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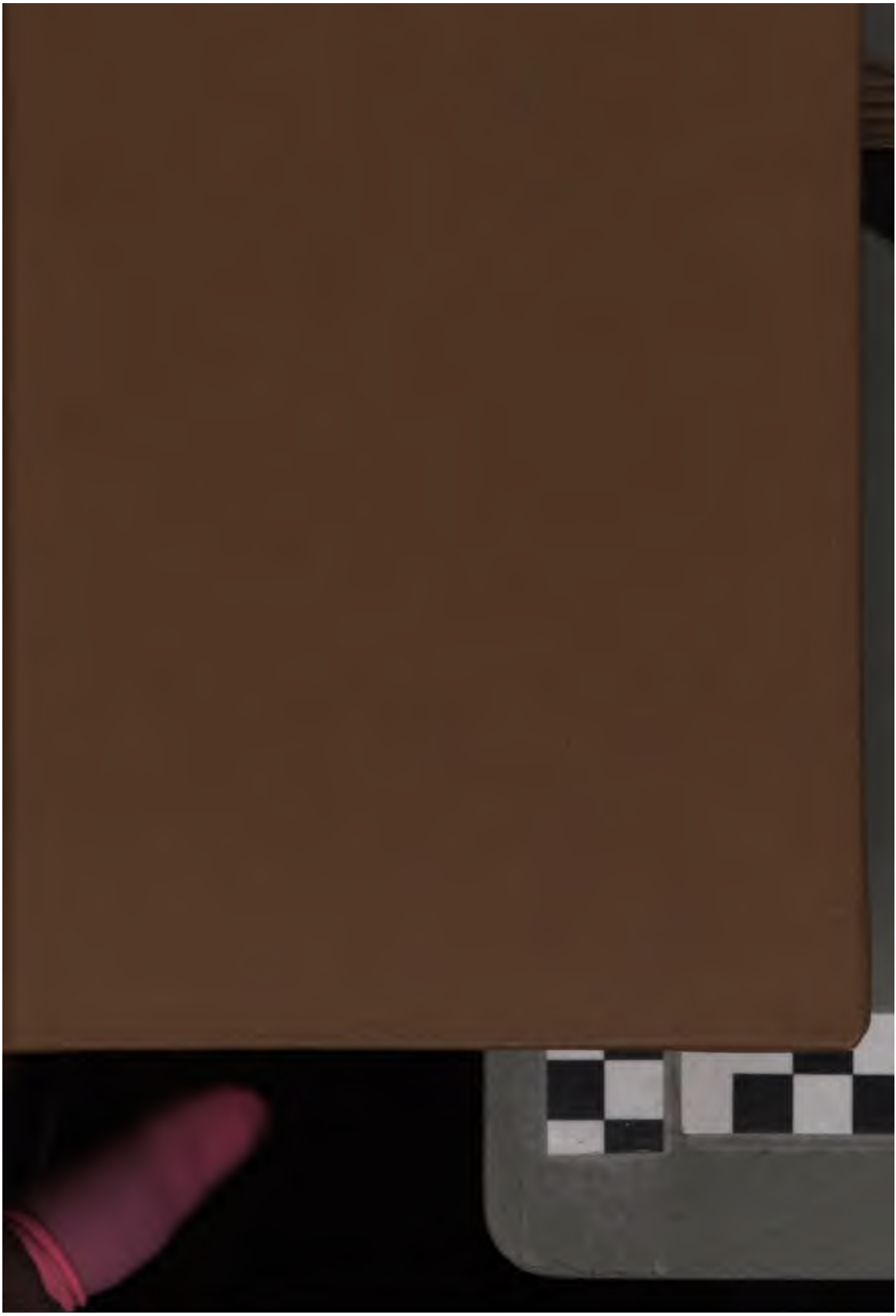

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THE MICHIGAN ASSOCIATION

OF

SURVEYORS AND CIVIL ENGINEERS.

ORGANIZED AT LANSING, MARCH 25, 1880.

KALAMAZOO, MICH.:
KALAMAZOO PUBLISHING CO., PRINTERS AND BINDERS,
1893.

THE MICHIGAN ASSOCIATON OF SURVEYORS AND CIVIL ENGINEERS.

ORGANIZED AT LANSING, MARCH 25, 1880.

OFFICERS:

PRESIDENT, PROF. CHARLES E. GREENE of Ann Arbor.

VICE PRESIDENTS, BY CONGRESSIONAL DISTRICTS,

First District—Vacant.
Second—JOHN K. YOCUM of Washtenaw, P. O. Waterloo.
Third—C. M. C. SNOVER of Jackson, - " Jackson.
Fourth—FRANCIS HODGMAN of Kalamazoo, Climax.
Fifth—H. C. PEARSONS of Ottawa, - - " Ferrysburg.
Sixth—H. D. BARTHOLOMEW of Ingham, " Lansing.
Seventh—JOHN J. WATKINS of Lapeer, " Lapeer.
Eighth—E. F. GUILD of Saginaw, - - - " East Saginaw.
Ninth—GEO. E. STEELE of Antrim, - " Elk Rapids.

SECRETARY AND TREASURER, J. E. SHERMAN of Lansing.

EXECUTIVE COMMITTEE.

D. SKEELS of Grand Rapids, M. W. BULLOCK of Howell, PROF. R. C. CARPENTER of Lansing, and the PRESIDENT and SECRETARY, ex officio.

SPECIAL COMMITTEE ON MANUAL.

PROF. R. C. CARPENTER of Lansing, THOMAS LOVE of Avery, GEO. E. STEELE of Elk Rapids.

THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

THE CONSTITUTION.

PREAMBLE

For the purpose of improving ourselves in the knowledge of our profession and securing greater uniformity in our methods of practice, we, the undersigned civil engineers and surveyors, hereby associate ourselves together under the name of the Michigan Association of Surveyors and Civil Engineers, and adopt the following as our constitution and by-laws:

SEC. 1.—OF MEMBERSHIP.

Any surveyor or civil engineer in good standing in the profession may become a member of this Society by signing the constitution and paying two dollars into the treasury: *Provided*, That all applications for membership shall be endorsed by at least one member of the Society, and shall be placed in the hands of the executive committee at least three months before an annual meeting; and further, that each applicant shall receive a three-fourths' majority vote of the members present at any regular meeting, not less than a quorum being present.

SEC. 2.—OF OFFICERS.

The officers of this society shall be a president, a vice-president in each congressional district in this state, and a secretary who shall also be treasurer.

The treasurer shall give bonds in such sums as the Society shall from time to time determine.

SEC. 3.—DUTIES OF OFFICERS.

The duties of these officers shall be such as are performed by similar officers in other societies. They shall hold their offices for one year, and until their successsors are elected and qualified.

SEC. 4.—OF ELECTIONS.

Elections of officers shall be by ballot, and shall be held on the last day of the regular meeting in January of each year.

SEC. 5.—OF AMENDMENTS.

This constitution may be amended at any regular meeting by a majority of two-thirds of the members present: *Provided*, That such amendment shall have been submitted in writing to the executive committee at least three months before an annual meeting.

BY-LAWS.

SEC. 1. A quorum for the transaction of business shall consist of ten members.

SEC. 2. There shall be a regular meeting in each year, commencing on the second Tuesday in January, at two o'clock P. M.

SEC. 3. Special meetings may be held at any time on call of the executive committee.

SEC. 4. There shall be an annual due of one dollar, payable on the first day of the regular meeting; and no member of the Society shall be entitled to vote or to any of the rights, benefits, or privileges of the Society while in arrears for dues.

SEC. 5. There shall be an executive committee of five members, of which the president and secretary shall be members *ex officio*, who shall have general charge of the business transactions of the Society. This committee shall be appointed by the president, and its members will hold their office for one year and until their successors are appointed.

Special committees will be appointed at any time when their services are demanded.

STANDING RESOLUTIONS.

MANUAL.

Resolved, That a committee of three be appointed to confer with the commissioner of the state land office in regard to compiling decisions of the courts and adopting methods of establishing lines and corners in this state; also to bring the matter before the next legislature.

Resolved, That members of the Society and others interested be and are hereby requested to furnish the chairman of the committee on manual with field notes, as taken in the field, of one or more sections they have subdivided; also diagram and full description of (the same) lines and corners as they appear of record, selecting such sections as will, in their judgment, assist the committee in their work, the object being to secure the committee a large number of representative cases.

Question of riparian rights was by resolution referred to the committee on manual.

LAND-MARKS.

Preamble. In view of the rapid destruction of land-marks which is being carried on, by destroying the witness-trees and obliterating the evidences of the United States survey, and in view of the expense and difficulty of restoring these corners when lost, the ill-feeling and litigation which follows their loss,

Resolved, That we recommend to the people of the state and to boards of supervisors that immediate steps be taken to preserve all the corners of the United States survey under the act of the legislature of 1879 (Act No. 205, Laws of 1879); and

Resolved, That in perpetuating these corners the best and most durable materials should be used for land-marks, and that they should be properly lettered and numbered for the corners they designate; and

Resolved, That as a matter of public economy we recommend that such work should be done, not by the person who will do it for the least money, but by the persons who will be likely to do it the most thoroughly; and that all obtainable evidence in regard to the locations of these corners should be got together and thoroughly sifted by the surveyor before any such land-marks are placed.

ABSENT MEMBERS.

Resolved, That all persons who have been in attendance at any session of this (first) meeting, or who have already written asking the privilege of membership, be allowed to join the society, with full membership upon paying the fee to the treasurer.

Members of the profession are by resolution requested to sub-

mit to the executive committee their views as to whether the Society shall institute examinations and grant certificates of qualification for surveyors.

ROLL OF MEMBERS WITH P. O. ADDRESS.

Arnold, A. R., Mt. Pleasant.
Bullock, M. W., Howell.
Bailey, M. H., Dimondale.
Beden, S. N., Pine Run.
Bannister, A. M., Jackson.
Bartholomew, H. D., Lansing.
Carpenter, Prof. R. C., Lansing.
*Cook, Percy T., Brooklyn.
*Cooley, Sloan, Four Towns.
*Caukin, H. M., Greenville.
Davis, Prof. J. B., Ann Arbor.
*Drew, A. L., Three Oaks.
*Donovan, Wm., Lansing.
*Dixon, J. R., Boyne Falls.
Eaton, Albert, Otsego.
*Fosdick, A. A., Gaylord.
Guild, E. F., East Saginaw.
Gardner, Albro, Allegan.
Greene, Prof. C. E., Ann Arbor.
Hollister, C. E., Laingsburg.
Hodgman, F., Climax.
*Hyde, Chas. B., Jackson.
*Heald, P. C., Midland.
Jipson, W. C., Blissfield.
Kent, Burton, Adrian,
Leavenworth, I. H., Sag. City.
Love, Thomas, Avery.
*Lawton, C. D., Lawton.
*Lovewell, N., Coldwater.
Mason, Lyman, Owosso.
*Masson, Geo., Detroit.
*Martin, E. C., Evart.
*Mitchell, Jno A., Ludington.
Olmsted, H. F., Midland.
Palmer, Jno. O., St. Johns.
Pearsons, H. C., Ferrysburg.
Pierce, A. J., South Haven.
*Palmer, A. H., River Raisin.
*Palmer, F. A., McBride's.
*Reed, A. L., Port Huron.
Skeels, D., Grand Rapids.
Stage, M. B., Clio,
Smith, E. C., Pontiac.
Snover, C. M. C, Jackson.
Steele, Geo. E., Elk Rapids.
*Sinclair, A., Port Huron.
Smith, Amos, Vandalia.
Sanborn, J. M., Pine Run.
Smith, J. N., Bath.
*Strudwick, Henry, Bad Axe.
Sherman, J. E., Lansing.
*Thompson, H. C., W. Bay City.
Teed, A. J., Cadillac.
*Terry, H. E., Pontiac.
*Teller, Isaac, Cohoctah.
*Todd, O. H., Colon.
*Vincent, Wm, Manistee.
*Vanzalingen, H B. W., Musk'n.
White, Thomas, Alpena.
Watkins, John J., Lapeer.
*Whallon, J. M., Fitchburg.
*Welles, B. F., Marshall.
Yocum, J. K., Waterloo.

*Under the standing resolution as to absent members.

FIRST ANNUAL MEETING

OF THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS. HELD AT LANSING, MARCH 24TH, 25TH, AND 26TH, 1880.

SECRETARY'S REPORT OF THE PROCEEDINGS.

This meeting and organization resulted from the circulation of the following call:

LANSING, MICH., Feb'y 28, 1880.

DEAR SIR:—Permit us to address you, not as assuming to represent the profession of surveyors and civil engineers of the state, but as having the welfare of our profession at heart and desiring to promote its interests and the interests of its patrons.

We believe there is urgent need of greater uniformity in our methods of practice, and a demand for greater certainty in results in our work.

You will agree that our results should always be such as will be sustained by the courts. With such results we can satisfy our patrons and avoid litigation by them.

We believe that our state law with reference to surveys is grossly inadequate; that correct work by one should be as official, legal, and entitled to record as any by another.

It may not be advisable to abolish the office of county surveyor, but in the courts county surveyors and others stand on equal footing. Why should not all good work be equally well backed by statute, and all have the advantage of its prestige?

Who better than we to take the lead in some wholesome measure, and what time better than now?

We submit whether the decisions of the courts on questions of boundary should not be compiled and in our hands for daily reference?

We believe united action of the profession is demanded. To that end we invite you to attend with us and take part in a meeting at the new state capitol, to begin on Wednesday, March 24, next, at 2 o'clock P. M.

Bring any questions arising in your practice that may be of interest to yourself or others—any doubtful or difficult case. This is important; past experience must light the future. Bring your transit, or compass, and chain for comparison. Let us have a collection of old instruments, and new.

We will begin business at the hour named by electing a temporary chairman and secretary, and the appointment of committee on organization, and on questions for discussion. We believe the latter necessary to avoid waste of time in desultory discussion. With report of the former we can go to work.

We have secured special railroad and hotel rates so as to materially lessen the expense of coming.

Again we invite you to be present, and we hope there is time to shape your engagements to that end.

Very respectfully,

R. C. CARPENTER, Lansing.
E. F. GUILD, East Saginaw.
P. C. HEALD, Midland City.
BURTON KENT, Adrian.
A. L. REED, Port Huron.
D. SKEELS, Grand Rapids.
WM. VINCENT, Manistee.
J. B. DAVIS, Ann Arbor.
CHAS. E. GREENE, Ann Arbor.
FRANCIS HODGMAN, Climax.
THOMAS LOVE, Avery.
A. SINCLAIR, Port Huron.
GEO. E. STEELE, Elk Rapids.
THOMAS WHITE, Alpena.

The assembly took place in the pioneer room of the new Capitol at the hour named in the call, and was called to order by Thomas Love, of Berrien county. Strangers to each other personally, but the fact was quickly forgotten in the interest of the occasion.

The permanent organization was the result unanimously desired, and was effected on the second day. The articles of association, standing resolutions, officers duly elected, and roll of members are elsewhere given, grouped for convenient reference. They need not be repeated here. It remains, then, to present the discussions

had. These were broken into by the work of organization, but it would appear best to give them here compact—each subject by itself.

"Shall we make and publish a manual as a guide for practice in this state?"

The expression was strongly in favor of such a work, as being the best way to secure uniformity of practice; the work to contain statutes and decisions of courts on boundary; also cases taken from actual practice and adopted as precedents by this Society. Referred —see standing resolution.

As to publishing, Prof. Davis volunteered to consult the various publishers of such works and report terms at next meeting

"What is the best method of perpetuating corners?"

Not decided. From the lengthy discussion of this question the following points are noted:

We should have a cheap, durable monument bearing certain marks, defined and protected by the law over the whole state alike

Cut stone was objected to on the ground of cost and weight—otherwise desirable.

Marble and cement.—Held same as cut stone with added objection of uncertainty as to durability; the latter depending on the quality, which is hard to determine.

Iron is used in various forms,—in Saginaw cast in form of a hollow cone twenty inches high, with a wide flange at the bottom and a small solid cap on top. The president exhibited a similar arrangement, without the flange, and having an iron pin to be driven for corner within the cone.

Iron in these special forms was objected to as too costly. In localities where the soil is impregnated with salt it oxydizes and disappears, and also where there is a market for old iron is unsafe

The wooden stake appears to be the most common corner mark in use; it should be of the most durable wood accessible, and its identity provided for by means of broken crockery, glass, or brick buried about it, or with stones filled in around it.

Noted that in the deep sand soil of the west shore, with surface liable to shift, monuments or stakes must be put down very deep.

The lime corner—simply a hole made deep as desired with a crowbar or small stake and filled with lime—was very highly recommended by the two or three gentlemen who have used it

"Cheap, easy to transport, easy to set, and very hard to remove," is what they say of it.

It is hoped that a certain glassy product of our iron furnaces now wasted may prove capable of being moulded and made available for monuments. Mr. Steele will investigate and report at next meeting.

Good witnesses and a full record are essential. Record should describe the monument, the means provided to preserve its identity and the witnesses.

PERPETUATING BENCH MARKS.

Benches can only be perpetuated by the continuous care of the engineer.

No set stone or monument should be used as a bench, but only the most immovable points. The water table of brick or stone buildings is most frequently used. Benches should not be known to, nor used by the public. All elevations should be furnished by the engineer. In no other way can any connected system of grades be kept up.

THE MIDLAND RESERVATION.

Question submitted by Mr. Olmsted.

This reservation contains 6,000 acres. Form, parallelogram, and lying along south side of Tittabawassee river. Course of river, southeasterly. The township was subdivided in 1831, and the section lines closed on boundary of reservation. Subdivision of the township was extended over the reservation in 1839. Section lines not continuous across the river. Original corners on reservation boundary are all lost, and but few corners inside the same can still be identified.

Query: How to proceed to establish the lost corners.

The method submitted by Mr. Skeels was recognized as correct, to-wit:

First set the corners on the boundary, following up the method and order in which they were originally placed. From the points so established, continue the lines across the reservation, passing through the known corners within. Any of these lines lacking a known corner inside, give an intermediate course between the adjacent lines, preserving proportionate distances to known corners, according to U. S. notes.

INSTRUMENTS.

The Stadia.—An instrument of value in topographical work, and in experienced hands capable of very accurate measure; will not supplant the chain, but is useful in many ways. The micrometer is not especially liable to get out of order, and if it does, can be easily re-adjusted. Prof. Davis and Mr. Steele gave methods of replacing the cross-wires when lost.

EFFECT OF THE SUN'S HEAT ON THE TRANSIT.

This is a fruitful source of error. Remedy: Revolve the transit on its axis often, so that all parts may become equally heated; or, shade the instrument altogether.

THE SOLAR APPARATUS.

General conclusion: The solar apparatus will not replace the needle, and only becomes of great value where the needle fails, and is just about equally reliable.

Prof. Davis exhibited a simple, practical, and cheap solar attachment for transit telescope. More calculations required than with Burt's. Prof. Davis will give the formulæ to any who send to him for them.

STANDARDS OF LENGTH.

Mr. Steele exhibited his 6-foot standard obtained at the office of the U. S. coast survey at Washington. The state standards in the custody of the State Treasury were found to consist of an old brass yard, and a new brass metre.

Mr. Amos Smith exhibited an adjustable link, used to correct the chain to standard. He has ten of them in his chain—procured of E. A. Fox, 204 LaSalle street, Chicago.

The chains brought to the meeting were compared, and several found to vary from standard. One was found to be eight inches too long.

A fine collection of instruments was exhibited. Messrs. Buff & Berger, Beckman, W. & L. E. Gurley, and Heller & Brightly, manufacturers were represented.

Mr. L. E. Gurley and Mr. Beckman were present and took part. Mr. Gurley gave an extended history of the manufacture of instruments, and of the improvements which have been made.

"SIGHT" OR LINE TREES.

Question: Are they monuments of government lines?

Act of Congress approved February 11, 1805, was read as settling this question in the affirmative.

As a result of the discussion which followed, it seemed to be granted that these trees, so long as standing and identified as such, cannot be disregarded,—that line must pass through them,—but further, that the surveyor is not called upon by either law or reason to perpetuate them by permanent monuments.

RECORDS.

The most usual form of record book appears to be one with the left hand pages blank for platting; the right hand ruled for notes. The latter should be very full, describing what is found, what done, and the marks made and left by the surveyor. The practice of using letters or figures in the notes as references to the plat, instead of writing out the notes in full, was discouraged, as tending to confusion, uncertainty and error, and for a public record the practice is entirely inadmissable. (The secretary ventures to give his opinion, that no system of taking and recording notes can be devised superior to that of the United States survey, which is, to describe the beginning point and then follow the successive steps of the work, in their order of occurrence to the closing point; further, that theplat is only accessory,—need carry only numbers expressing areas, and may therefore be made on a small scale; further, that for a public record a serviceable index is of great use, so that the surveyor may readily find notes of all that has been done by any surveyor on a given line.)

SUBDIVISION OF FRACTIONAL SECTIONS.

As the governing principle, this was presented: "Study to produce the same result as to location of lines and corners as would have been reached had the section been full."

Mr. Steele submitted that the words "north" and "west" in the notes of the U. S. survey, referring to the direction of lines are not understood to mean necessarily exact cardinal directions, but are to be interpreted by the lines found on the ground.

When the outside lines and corners of a section exist, subdivision is independent of all outside of those lines and corners.

In case of a patent by government, conveying a subdivision not

expressed on the plat returned by the Surveyor General, the language of the patent will govern in determining its bounds. In case of the patentee of a regular quarter section deeding the same in two parcels, as E. ½ and W. ½, "according to the U. S. survey," the surveyor will place the dividing line midway, regardless of quantity.

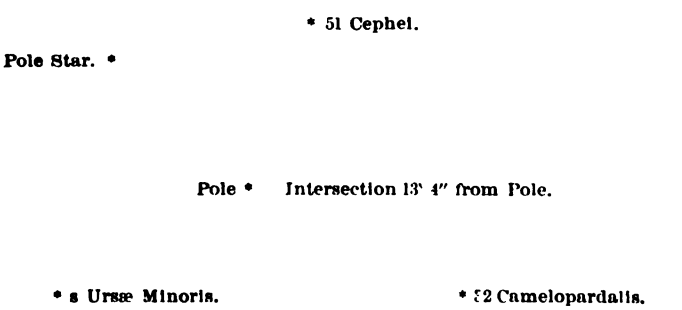
The quarter post on north or west boundary of township, should be placed on the boundary midway between the corners of the same section, regardless of the quarter post for the section across the boundary north or west as case may be, (except section 6.)

Again, the posts for lines closing on north or west boundary of township are often found to be off the boundary line, one side or the other. Query as to whether the boundary should be deflected to pass through these posts was definitely answered to the effect that the boundary lines are established before these closing posts are set, and are independent; that the closing posts like sight trees, serve to determine the location of the section line, but that the latter terminates on the boundary.

In connection with sub-division of sections, Mr. Hodgman called attention to a case judicially decided, and reported in 2 Clark's Iowa, 139.

VARIATION OF THE NEEDLE.

Prof. Davis stated the daily variation to be from five to twenty minutes. He also gave the following simple method of locating a meridian. The four stars used and their relative positions are here shown. (The lines can be penciled on):



If a line be drawn connecting s Ursæ Minoris (the Pole star)

with 32 Camelopardalis, and another connecting 51 Cephei with s Ursæ Minoris. Their intersection is about 13′ 4″ from the pole on a line parallel to a line joining s Ursæ Minoris to 32 Camelopardalis. This intersection is on that side of the pole 51 Cephei and 32 Camelopardalis. If a person suspend a long plumb line with a heavy weight, the weight being in a vessel of water, the following observations may be made: By illuminating this line with a light, one may place one's self southerly from the line; and seated in an easy position, sight the line so as to cover the place the pole is judged to occupy. Having the eye in this position, direct an assistant to set another light in range of the plumb line, and far enough away so that the light will not appear too large. Have the assistant drive a stake where the light is. Let the assistant move away a little, and direct him to set another stake. As many may be set as desired. By daylight the bearings from the stakes to the plumb line may be taken, and the average of these may be regarded as the bearing of a meridian line. But little practice seems to be needed to enable one to find a north and south line in this way to within five minutes of its true place.

COUNTY SURVEYORS VS. REGISTERED SURVEYORS.

This question was submitted in this form: "Shall the office of county surveyor be abolished?" and was freely discussed. It appeared to be a question too important to be decided without mature consideration, and was disposed of by the passage of the resolution inviting members of the profession to communicate their views to the executive committee, the latter to submit the matter to the next assembly of the society.

To show the ground traversed by the discussion, several of the addresses are here reproduced:

Geo. E. Steele said:

As to whether the county surveyor's office should be abolished or not, I say, after mature reflection on the subject, "Yes, the sooner the better." I am aware, however, that this, like most well established practices, has its faithful defenders, and that important changes in our laws and customs had better be brought about by degrees, rather than in the nature of a revolution.

As an office, I cannot consider it in any other light except that of a relic of the by gone—a fossil footprint.

The framers of our constitution did not think enough of the office to mention it; but our law makers, who may have had more *cardinal virtues* than *cardinal points* about their make up, first gave us an introduction to this official dignitary in Chap. 10, Sec. 95. Comp. Laws, where the sec-

tion commences by saying, "The county surveyors for each organized county shall be elected at the general election," etc.

The officer, armed and equipped with any old brass kettle he can pick up for a compass, a bed-cord to measure with (mark, the law is silent as to what instruments he shall use), starts out, after giving two thousand dollar bonds that he will be "faithful" and "impartial." Yes! It takes a good deal of faith to keep up a surveyor when there is not much work to do, and last year's jobs are not yet paid for; and he must be very impartial, too, if his lines do not run around some of the big pine trees. He finds when his surveys come to be tested by the courts that he has been but a "man of straw" standing guard over an empty sepulchre. He takes the witness stand and the sprig of the law says, "Tell us, now, all about this survey." Witness goes on to state with some gravity that he is the county surveyor of———, when the court calls out, "State *how* you made the survey, *what were your instruments*, and *what has been your experience*. This court cares nothing about your official dignity." At this he collap es. We cannot claim that there is as much need for a county surveyor as for any county officer, because some officers act only in an official capacity, as for instance, the county clerk, whose place no one else can fill, and whose seal on a document is given in proof of its official value. But any person may make legal and binding surveys; and if we need a county surveyor, then, with just as much reason, we need a county *doctor*, or a county *shoemaker*. It takes much study and special fitness before a young man becomes a competent surveyor; but the law steps in and says to such a man, "Step one side; there is a political aspirant who wants the place." The law should encourage the best talent, and throw open to all this business as it does others, and leave each man's work to stand such tests as may be applied to it; or else, by a system of thorough examination weed out the incompetent and elevate the profession. The records of surveys should be in the office of the register of deeds, and all surveys should be there entered of record before they are permitted to have any value. A system should be devised also to correct instruments of measure.

With some such improvements, if the office cannot be abolished, we may go on with our work as an association.

But in a state like Michigan, with over 36,128,000 acres of land, an extensive lake coast giving rise to many puzzling questions of boundary, and an unprecedented immigration and progress, it would seem that we might reasonably ask for an improved system of surveys.

Mr. Pearsons said:

Of all the laws of the state that require to be overhauled, rejuvenated and modernized, perhaps there are none claiming more urgent attention than those pertaining to the perpetuation of our land marks. While it is conceded that we have the best system of public surveying in the world, it is a sorry fact that we have also the poorest work in the world.

The government marks are but of a temporary character,—were only designed to be such,—to last merely till the land should be occupied, when it was supposed the owners of the land would have sufficient interest in the marks to perpetuate them in a durable manner. Laws have indeed been enacted looking to this end, but their inefficiency is now painfully apparent.

County surveyors have been provided, whose duty it is to re-establish, when called upon to do so, any of the government lines and corners that may be lost. But when we look at the manner in which these officers are appointed, we readily see the cause of their inefficiency.

The first thing looked at, with regard to the qualifications of a candidate, is the color of the political stripe in his coat. This being satisfac-

tory, the candidate needs only to be a legal voter, when he is forthwith made a "county surveyor,"—considerations of fitness for the duties of the office, with regard to scientific and practical attainments, being too often neglected, for the law imposes no conditions in this matter.

Again, the uncertainty of the tenure of office stands in the way of the surveyor in attaining either the information or the instruments to make him useful and efficient in the way of his duty, for by the time he can acquire these, his office is transferred to another.

Moreover, the laws have placed him in a very humiliating position. He is required to give bonds for the faithful discharge of the duties devolving on him,—indemnifying his clients against damage by incompetent work, and to take an oath of fealty to the commonwealth; then, after doing all this, he finds the following expression in the state laws: "The county surveyor or other competent person" may do his work.

The state of New York commenced the reformation of her system of surveying over three years ago.

But in Michigan any kind of work is good enough. Whether it be a section, township or county corner that is to be perpetuated, all are treated alike, for the state has imposed no conditions in this matter, nor have the counties given any instructions to their surveyors for the manner of perpetuating them. The result is, that all conceivable methods are employed, depending on the character and capacity of the acting surveyor, from a good marked stone, with references to suitable permanent objects, to a mere slip of a sapling set in the ground, without any reference whatever, and in so temporary a manner that it disappears with the first frost or the first fire.

A little cobble-stone, without mark of any kind to distinguish it from the other stones in the ground, is not unfrequently all that marks the place of an important corner. "This is good enough for Michigan."

The remedy for all this is simple. We have only to formally abolish the office of county surveyor, and commence anew. I say, "formally," for the office is already dead,—made so by law allowing "other competent persons" to perform the functions of that office. What would we think of allowing any "competent person" to perform the duties of our recorder, our treasurer, our clerk, or of the judge of any of our courts, leaving the lawful incumbent looking on, with his thumbs in his mouth? Yet this is precisely the position in which the county surveyor is placed. The laws relating to the county surveyor are thus seen to be only a simple farce, a direct insult to the incumbent of the office, and a positive disgrace to the state.

If the people will have a county surveyor, let them impose on him the conditions of qualification, of practical training and general knowledge, fitting him for the duties of the position. Then give him adequate pay and at least a term of six years, so that he can afford to qualify himself as do other professionals. Or better, let those who would follow the profession of surveying in the state pass a satisfactory examination before a board of examiners, whose duty it shall be to determine the fitness of such candidates for such duty, as regards their scientific attainments, practical knowledge, and general ability.

Then let the successful candidate be licensed by the governor of the state as a "state surveyor," and without limit with regard to time,—except for cause the license may be revoked by the circuit court of any county. And at the same time, let the state, or the several counties, adopt some uniformity of plan with regard to the manner of perpetuating the government corners.

When the foregoing or other equivalent modifications are made in our surveying laws, we shall be on the way of improvement; otherwise ours is a "down grade."

Mr. Hodgman said:

Because of the lack of any restrictions in regard to the competency of county surveyors, I would favor abolishing the office, *if* something better can be substituted; otherwise not. Twelve years' extended experience and observation convince me that in southern Michigan nine-tenths or more of the people demand the services of a county surveyor as final arbiter of disputed lines. If they generally thought that the work of a county surveyor was of no more legal value than that of any other surveyor, they would almost without exception favor a measure which should provide that none but qualified persons should hold the office and make their work final:

They favor this, on these general principles, that

1st, A competent surveyor is a better judge of facts on the ground than courts or juries.

2d, That a final settlement of disputed cases without the enormous expense and uncertainty of a resort to the courts is more important than extreme nicety or accuracy of work.

The strong points of our present system are:

1st, The provision for placing permanent landmarks at all corners of the United States survey worked from by the county surveyors.

2d, The provision for keeping a suitable record of these corners. These two points I esteem to be of great importance.

3d, The county surveyor's work is very generally accepted as final, unless bearing on its face evidence of gross inaccuracy; and people thus avoid the notorious evils of a resort to litigation. People had rather trust the location of their lines to a competent surveyor of their own election than any court in the country.

The weak points of the law are: That it permits incompetent men to hold the office of county surveyor; that it is not in harmony in all respects with the laws of the United States and the decisions of the courts.

What I understand and believe to be wanted are:

1st, Laws and rules of practice to conform with the United States laws as expounded by the highest authorities.

2d, Competent, honest men to make the surveys.

3d, A complete accessible record of these surveys.

4th, Careful work done according to these laws to be final and not subject to change with every new surveyor who comes along. I can conceive of no good to be obtained by abolishing the office of county surveyor, unless the act provides better means for securing the points named.

R. C. Carpenter said:

Although never having had much experience in the work of land surveying, I can see many valid reasons why the office of county surveyor should be abolished. Under our present system the patronage and professional work to a certain extent are subject to every change of political fortune. In choosing between rival candidates for the position of county surveyor, the question of competency is never raised. A man rises or sinks with the political party to which he is attached. A case, in fact, happened in one of the central counties of this state, where a competent civil engineer ran for county surveyor on the ticket of the weaker party, and was beaten by the opposing candidate, who was not only ignorant of the first principles of surveying, but who had had no practical training.

This practice answers very well when applied to those offices that require no special training to fill, but it is in the highest degree discouraging to a man who has fitted himself for this profession as a business,

to find that the exercise of his profession depends on the smiles or frowns of a political convention.

We claim that the state has no right to interfere with the business of a surveyor more than with the business of a physician or a lawyer. Yet it does have a right to insist that poor surveying shall not be tolerated. It has the same rights in regard to the other professions, although it is enforced in regard to the legal profession only. What we need is that the state will remove the present unreasonable legal restrictions against our business, but yet allow us to establish a bar which can only be passed by competent men.

Mr. Bullock said:

When we take into consideration that the nominees for the office of county surveyor are never or seldom nominated or elected for their merit or qualifications for their duties, and whilst the real value "*pro bono publico*" consists in their making *proper records of their acts*,—and even this, their most essential duty, is more honored in the breach than the observance,—and also that he is a nonentity in law, and only put on the ticket to help fill it out, one need not feel very elated in holding such an anomalous office, and would think that of a necessity the office should be abolished, which I am in favor of if some system can be arranged so that suitable records can be, and must be kept; for as I said before, in *this* consists the real value of this or any such office; for by the records former errors can be detected, any irregularity in the original survey identified,—and any system which will promote the keeping of such records will be the best for the *public good, which ought to be our aim.*

Whether to abolish the office entirely, or make such radical change in the laws regarding county surveyors, as to establishing a board of examiners and of registration, or combine both, is the question in my mind.

But when we consider that the location of corners and of boundary lines is a question of facts and not of men, and that our statute laws are in conflict with congressional enactments, which provide that the return as made by the U. S. surveyor general shall be considered and are the accurate or legal survey, and the distances on such returns be considered the actual measurements, and that any such facts definitely sustained would be held valid in the courts; and so they ought, whether set forth by the county surveyor, or by a surveyor examined and registered, or by a farmer with ranging poles and a clothes line.

I say when we consider all this, I can see no way for making a survey legal or be so recognized by the courts, except by getting it right; but any system that will help doing this, and more especially keeping and making a correct record of surveys, will meet my approval. My mind would be, either abolish the office and make it obligatory upon every surveyor to pass an examination and so register himself suitable, and that he be required to make a record of his surveys in a proper book and manner in the register of deeds' office; or change the law to the effect that no one can be eligible to the office of county surveyor unless he has passed such an examination and has so been registered; and that he must make suitable record, and that the law give his acts preference. Now, so far as I am concerned, I think this last method much the simpler and more definite, and much more satisfactory to the public.

Prof. Davis said:

I would let the office of county surveyor alone. Take measures to provide all members of this Society, and all others who desire it, with a certificate of proficiency as surveyors. Take measures further to in-

form the public thoroughly of this condition of things. Grant these certificates only upon a thorough examination into the applicant's acquirements, theoretical and practical. Besides this set examination, bring to bear upon each case an exhaustive discussion of the candidate's moral status by the Society in executive session. In short require the highest reasonble qualifications in all directions for the bestowal of a certificate. The county surveyor will soon be obliged to "qualify" at the bar of this Society as well as under the law. When this is accomplished, the necessity for continuance will have disappeared, and the law will be repealed for the asking, I think, because the request will be strong and definite from all quarters.

Mr. Donovan, in a very eloquent address, said that among our various standards we need a standard to measure men by—to compare ourselves by, both as surveyors and as men.

Mr. Arnold, in closing his remarks, called upon us to fix a high standard of excellence, to verify every operation, and in perpetuating the landmarks of our work to plant the corners deep, make the bearings sufficient, and finally to make the record tell to those who follow us, the whole truth.

Mr. Bailey spoke very earnestly of the paramount importance of integrity, and full qualification in our work.

Mr. Teed made the point that the office of county surveyor is practically a monopoly, because the people believe themselves not bound to abide by the work of any surveyor but the one duly elected.

Mr. Pierce, Mr. Hollister, and others also spoke, and the discussion as a whole was earnest and disinterested.

With this closes report of proceedings.

The secretary would add:

Decisions of our Michigan Supreme Court on questions of boundary would seem not numerous. The following references are here given:

8th, 18; 10th, 125; 14th, 53; 18th, 196; 19th, 325; 28th, 182; 30th, 282; 31st, 270; 37th, 549; 41st, 595; 1 Doug., 119.

A FORMER ORGANIZATION.

The secrectary has received from E. F. Guild the printed report of the first and second sessions of the Surveyors and Civil Engineers' Association of Michigan, organized at Lansing, Aug. 20, 1868.

The objects of this assembly, as set forth in the call, were to attain more uniformity in the work, to procure a revision of the law in regard to surveying "which now is of no practical use except

as to recording landmarks," and to consider the question of forming a surveyor's association.

Organization was effected with W. L. Coffinbury of Grand Rapids, president, and H. M. Caukin of Greenville, secretary. The discussions covered practically the same grounds as at our own first meeting.

The second meeting, held at Grand Rapids, May 5th and 6th, 1869, was largely devoted to the discussion of county surveyor system. A resolution was proposed for future action looking to a concerted movement to secure the abolition of the office and the substitution of examined and licensed surveyors.

The effort to secure uniformity of practice took this form:

Resolved, That we will adopt a set of principles and rules which we will follow ourselves, and recommend to other surveyors of the State to follow, for their guidance in surveys made by them.

The question of authority was settled by this:

Resolved, That in subdivisional surveys the acts of Congress and interpretations thereof by U. S. courts, shall be regarded as the highest legal authority, and that next in authority are the rulings of the Commissioner of the General Land Office.

It would appear that the old society was called together for the same reasons as the present one, and that in our discussions we have thus far followed its example.

It is hoped that the secretary of the old society will be present at our next meeting with the complete record of its proceedings.

A copy of this report is mailed to each member as per list herein given. Members needing more copies will please write the secretary, and say how many.

LANSING, MICH., Aug. 1, 1880.

SECOND MEETING

OF

THE MICHIGAN ASSOCIATION

OF

SURVEYORS AND CIVIL ENGINEERS.

HELD AT LANSING, JANUARY 11-13, 1881.

THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

ORGANIZED AT LANSING, MARCH 25, 1880.

OFFICERS, 1881.

PRESIDENT, PROF. CHARLES E. GREENE of Ann Arbor.

VICE PRESIDENTS, BY CONGRESSIONAL DISTRICTS.

First District—JAS. SANDERSON, - P. O. Detroit.
(330 Randolph St.)
Second—JOHN K. YOCUM of Washtenaw, " Waterloo.
Third—C. M. C. SNOVER of Jackson, - " Jackson.
Fourth—FRANCIS HODGMAN of Kalamazoo, " Climax.
Fifth—H. C. PEARSONS of Ottawa, - - " Ferrysburg.
Sixth—H. D. BARTHOLOMEW of Ingham, " Lansing.
Seventh—JOHN J. WATKINS of Lapeer, " Lapeer.
Eighth—E. F. GUILD of Saginaw, - - - " East Saginaw.
Ninth—GEO. E. STEELE of Antrim, - " Elk Rapids.

SECRETARY AND TREASURER, J. E. SHERMAN of Lansing.

EXECUTIVE COMMITTEE.

D. SKEELS of Grand Rapids, BURTON KENT of Adrian, A. L. DREW of Three Oaks, and the PRESIDENT and SECRETARY, ex officio.

SPECIAL COMMITTEE ON MANUAL.

PROF. R. C. CARPENTER of Lansing, THOMAS LOVE of Avery, GEO. E. STEELE of Elk Rapids, and FRANCIS HODGMAN of Climax.

ROLL OF MEMBERS WITH P. O. ADDRESS.

Arnold, A. R., Mt. Pleasant.
Bullock, M. W., Howell.
Bailey, M. H., Dimondale.
Beden, S. N., Pine Run.
Bannister, A. M., Jackson.
Bartholomew, H. D., Lansing.
*Blair, James, Adrian.
Brown, P. M., Smith's Creek.
Brown, Geo. M., East Saginaw.
Bonnell, B. C., Pioneer.
Brown, Thos. J., Mason.
Bradt, J. C., Marcellus.
*Baker, Chas. L., Ann Arbor.
Begle, Chas A., East Saginaw.
Carpenter, Prof. R. C., Lansing.
*Cook, Percy T., Brooklyn.
*Cooley, Sloan, Four Towns.
Caukin, H. M., Greenville.
Cummings, Geo. P., Marquette.
*Cobb, L. S., Winfield.
Cary, Harrison, Saginaw City.
*Cornell, Thomas, Ionia.
Collar, H. A., Grand Rapids.
*Cook, M. S., Manistee.
Davis, Prof. J. B., Ann Arbor.
Drew, A. L., Three Oaks.
Donovan, Wm., Lansing.
Dixon, J. R., Boyne Falls.
*Drake, A. P., Mason.
Dunbar, E. L., Bay City.
Eaton, Albert, Otsego.
*Fosdick, A. A., Gaylord.
Foster, R. J., Coopersville.
Fessenden, C., Romeo.
Guild, E. F., East Saginaw.
Gardner, Albro, Allegan.
Greene, Prof. C. E., Ann Arbor.
*Gillette, L. S., Niles.
Greiner, R. C., Grand Rapids.
*Goodell, E. S., Ecorse.
*Glaser, Chas. A., West Bay City.
Hollister, C. E., Laingsburg.
Hodgman, F., Climax.
Hyde, Chas. B., Jackson.
Heald, P. C., Midland.
Huggins, Andrew, Corunna.
*Hamlinton, Chas., Bronson.
Holmes, Chas., East Saginaw.
Hodgman, S. C., Traverse City.
Holden, D. F., Oviatt.
Hastings, S. S., St. Louis.
Herbert, F. H., East Saginaw.
Jipson, W. C., Blissfield.
Johnson, J. M., Bay City.
*Jenison, H. H., Eagle.
Kent, Burton, Adrian,
*Kinnefick, J. S., Capac.
Leavenworth, I. H., Sag. City.
Love, Thomas, Avery.
Lawton, C. D., Lawton.
*Lovewell, N., Coldwater.
*Lawson, J. S., Disco.
Mason, Lyman, Owosso.
*Masson, Geo., Detroit.
*Martin, E. C., Evart.
*Mitchell, Jno. A., Ludington.
Mark, Geo. A., Hillsdale.
McElroy, Michael, East Tawas.
*Niles, I. P., Coopersville.
Olmsted, H. F., Midland.
Palmer, Jno. O., St. Johns.
Pearsons, H. C., Ferrysburg.
Pierce, A. J., South Haven.
*Palmer, A. H., River Raisin.
*Palmer, F. A., McBride's.
Pettibone, D. A., Bridgeport.
Reed, A. L., Port Huron.
Rothwell, H. G., East Saginaw.
Skeels, D., Grand Rapids.
Stage, M. B., Clio,
Smith, E. C., Pontiac.
Snover, C. M. C., Jackson.
Steele, Geo. E., Elk Rapids.
*Sinclair, A., Port Huron.
Smith, Amos, Vandalia.
Sanborn, J. M., Pine Run.
Smith, J. N., Bath.
*Strudwick, Henry, Bad Axe.

*Under the standing resolution as to absent members.

Sherman, J. E., Lansing.
*Smith, Richard, Port Austin.
Sanderson, Jas., Detroit.
Sears, Wm. B., East Saginaw.
*Thompson, H. C., W. Bay City.
Teed, A. J., Cadillac.
*Terry, H. E., Pontiac.
*Teller, Isaac, Cohoctah.
*Todd, O. H., Colon.
*Thornton, Wm., Grand Rapids.
*Treadwell, E., East Saginaw.
Vincent, Wm , Manistee.
*Vanzalingen, H. B. W., Musk'n.
Van Liew, E. S., West Bay City.
White, Thomas, Alpena.
Watkins, John J., Lapeer.
*Whallon, J. M., Fitchburg.
Welles, B. F., Marshall.
*Woodard, C. S., Ypsilanti.
*Wilmarth, A. H., Sand Hill.
Yocum, J. K., Waterloo.

HONORARY MEMBERS.

John F. Monro, Detroit.
W. L. Coffinberry, Grand Rapids.

*Under the standing resolution as to absent members.

THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

THE CONSTITUTION.

PREAMBLE

For the purpose of improving ourselves in the knowledge of our profession and securing greater uniformity in our methods of practice, we, the undersigned civil engineers and surveyors, hereby associate ourselves together under the name of the Michigan Association of Surveyors and Civil Engineers, and adopt the following as our constitution and by-laws:

SEC. 1.—OF MEMBERSHIP.

Any surveyor or civil engineer in good standing in the profession may become a member of this Society by signing the constitution and paying two dollars into the treasury: *Provided*, That all applications for membership shall be endorsed by at least one member of the Society, and shall be placed in the hands of the executive committee at least three months before an annual meeting; and further, that each applicant shall receive a three-fourths' majority vote of the members present at any regular meeting, not less than a quorum being present.

SEC. 2.—OF OFFICERS.

The officers of this society shall be a president, a vice-president in each congressional district in this state, and a secretary who shall also be treasurer.

The treasurer shall give bonds in such sums as the Society shall from time to time determine.

SEC. 3.—DUTIES OF OFFICERS.

The duties of these officers shall be such as are performed by similar officers in other societies. They shall hold their offices for one year, and until their successsors are elected and qualified.

SEC. 4.—OF ELECTIONS.

Elections of officers shall be by ballot, and shall be held on the last day of the regular meeting in January of each year.

SEC. 5.—OF AMENDMENTS.

This constitution may be amended at any regular meeting by a majority of two-thirds of the members present: *Provided*, That

such amendment shall have been submitted in writing to the executive committee at least three months before an annual meeting.

BY-LAWS.

SEC. 1. A quorum for the transaction of business shall consist of ten members.

SEC. 2. There shall be a regular meeting in each year, commencing on the second Tuesday of January, at two o'clock P. M.

SEC. 3. Special meetings may be held at any time on call of the executive committee.

SEC. 4. There shall be an annual due of one dollar, payable on the first day of the regular meeting; and no member of the Society shall be entitled to vote or to any of the rights, benefits, or privileges of the Society while in arrears for dues.

SEC. 5. There shall be an executive committee of five members, of which the president and secretary shall be members *ex officio*, who shall have general charge of the business transactions of the Society. This committee shall be appointed by the president, and its members will hold their office for one year and until their successors are appointed.

Special committees will be appointed at any time when their services are demanded.

STANDING RESOLUTIONS.

MANUAL.

Resolved, That a committee of three be appointed to confer with the commissioner of the state land office in regard to compiling decisions of the courts and adopting methods of establishing lines and corners in this state; also to bring the matter before the next legislature.

Resolved, That members of the Society and others interested be and are hereby requested to furnish the chairman of the committee on manual with field notes, as taken in the field, of one or more sections they have subdivided; also diagram and full description of (the same) lines and corners as they appear of record, selecting such sections as will, in their judgment, assist the committee in their work, the object being to secure the committee a large number of representative cases.

Question of riparian rights was by resolution referred to the committee on manual.

The foregoing is the original. At this meeting the following was added:

Resolved, That the committee on manual be enlarged to four members; that they proceed with the work as rapidly as possible,

and that one hundred dollars be appropriated to defray their necessary expenses.

LAND-MARKS.

Preamble. In view of the rapid destruction of land-marks which is being carried on, by destroying witness-trees and obliterating the evidences of the United States survey, and in view of the expense and difficulty of restoring these corners when lost, the ill-feeling and litigation which follows their loss,

Resolved, That we recommend to the people of the state and to boards of supervisors that immediate steps be taken to preserve all the corners of the United States survey under the act of the legislature of 1879 (Act No. 205, Laws of 1879); and

Resolved, That in perpetuating these corners the best and most durable materials should be used for land-marks, and that they should be properly lettered and numbered for the corners they designate; and

Resolved, That as a matter of public economy we recommend that such work should be done, not by the person who will do it for the least money, but by the persons who will be likely to do it the most thoroughly; and that all obtainable evidence in regard to the locations of these corners should be got together and thoroughly sifted by the surveyor before any such land-marks are placed.

Absent Members.

Resolved, That all persons who have been in attendance at any session of this (first) meeting, or who have already written asking the privilege of membership, be allowed to join the society, with full membership upon paying the fee to the treasurer.

The Executive Committee.

Resolved, That the executive committee be directed to meet at least 60 days prior to each annual meeting of this society.

Said committee shall divide its work and designate one of its members to have charge of each subdivision so made, and of all correspondence relating thereto.

That members of this society, or of the profession, having questions of practice or topics which they wish discussed by the society, shall submit the same to the committee as early as possible during the year. All matters to come before the society, the committee shall, so far as possible, prepare and present in convenient form for its action.

That said committee prepare and distribute a programme of the business so arranged.

That the necessary expenses of the committee for such meeting shall be paid by the treasurer of the society.

Under this resolution the committee have divided with ref-

erence to matters to come before the Society's next meeting as follows: Mr. Kent will arrange for the reading of papers, and would remind the members that there is in their individual experience and research a fund of knowledge which it is one of our objects to bring out and place on record for the benefit of all. In this field let us not guard our "private marks" too jealously, but rather seek to contribute to the common understanding.

Mr. Drew will receive questions of practice and arrange them for discussion by the Society. Every one is invited to send any case he wishes to hear discussed, without regard to its supposed general interest. Mr. Drew hopes to be in receipt of a good number of cases, and will undertake to group them according to principles involved and submit them with appropriate resolutions, for the Society's convenient and definite action.

The Secretary is appointed to receive applications for membership in the Society.

The Committee will meet about Oct. 15, 1881.

SECOND ANNUAL MEETING

OF THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS, HELD AT LANSING, JANUARY 11–13 1881.

SECRETARY'S REPORT OF THE PROCEEDINGS.

The association assembled Tuesday, January 11, in the pioneer room, new capitol, and was called to order at 2 P. M. by the president.

The secretary will again present the proceedings by subjects instead of by order of occurrence.

The attendance was good, varying from thirty-six at the opening to nearly one hundred, with a corresponding interest and evident determination to accomplish the declared objects of the Society.

MEMBERSHIP.

Question occurred as to admission of new members under Sec. 1 of the constitution; it appearing that the rule requiring three month's notice had been complied with in but few cases. Question was referred to the executive committee, who reported the following resolution:

Resolved, That the resolution as to absent members printed on page five of the minutes of the Society for the annual meeting held in 1880, be continued in force for the present year.

The resolution was adopted, after which the names proposed for membership were voted upon one by one, with the result shown by the roll of members.

The names of G. D. Lewis of Tekonsha. and S. M. Bartlett of Monroe, were presented by the secretary but no information concerning them being at hand, they were referred to the executive committee.

The name of John F. Munro of Detroit was presented for honorary membership by Mr. Guild, and of W. L. Coffinberry of Grand Rapids by Mr. Skeels, and both unanimously voted.

AMENDMENTS TO THE CONSTITUTION.

The following were proposed, and were referred to the executive committee, to be presented for final action by the Society at its next regular meeting:

SEC. 1. To strike out from line five the words "shall be placed in the hands of," and from line six the words "at least three months before an annual meeting."

SEC. 2. By adding after the word "determine," in the last line the words, "and shall make a report of the finances of the Society at each annual meeting."

SEC. 5. By striking out all after the word "Provided," and substituting therefor the words "such amendments shall have been submitted in writing on the first day of said meeting, and referred to a committee for consideration."

THE MANUAL.

The committee placed in charge of this work at our first meeting reported that they had not yet entered actively upon its construction, preferring to place their general plan so far as matured before the Society, and be governed by its action. The points submitted were:

That the mathematics of surveying should be excluded so far as already supplied by text-books.

That it should deal with the principles involved in the practice of our profession, to define them clearly, and illustrate their practical application. Beginning with those understood, held to and applied prior to the institution of the United States rectangular system, and showing how they entered into that system, with a brief history of the latter.

That it should contain the laws of congress and the instructions to United States deputy surveyors from the beginning.

Then, all available decisions to United States and State courts arranged, so as to confirm the truth of certain pertinent propositions—for instance:

PROP. I. Corners fixed by the United States Survey cannot be removed.

PROP. II. Monuments are to govern in preference to courses, distances, maps, or computed areas.

The application and force of these several propositions to be illustrated by the presentment in connection of cases of actual occurrence.

That it should treat the magnetic variation of the needle in the endeavor to secure its common understanding and use. Finally, that while the work is by the surveyors of Michigan, and undertaken to serve their need, yet it is believed that it may prove of great value in all the public land States.

The committee set forth that while they feel competent to compile the decisions of the courts in a form to be of use, yet they do not expect to be able to evolve from within themselves, and formulate the whole range of principles with which the surveyor has to

deal during the practice of a lifetime. For whatever they accomplish in this part of the manual they rely largely upon a careful study of a large number of cases of actual occurrence, and appeal to each member of the Society to make it a matter of personal interest to contribute a share; that while the committee are the willing instruments, yet the manual must be the work of the whole Society.

The committee further submit that they have expressions of encouragement, and an active demand for the manual from surveyrs, lawyers, etc., from all parts of the state and abroad. That the question of publication will be easy of solution whenever the manuscript is ready. At the request of the committee, its number was increased to four, and Mr. Francis Hodgman appointed the additional member.

QUESTIONS OF PRACTICE.

CASE I. In 1838 the center of section twenty-one was established by bisecting the e. & w. ¼ line. About the same time a road was laid on the n. & s. ¼ line and irregularly fenced, so that the parties never joined fences along this line.

In 1858 the center of the section was again determined in the same manner—but changed. About this time ¼ post on n. side was dug out and lost. In 1866 the center of the section was again set in the same way, and again moved.

In 1871 the lost ¼ post on n. side was put in equidistant and on on right line between n. e. & n. w. corners. In 1877 the center was determined by the intersection of right lines joining opposite ¼ posts, and so established, making the fourth center. Query: Which is the legal center? Ample discussion followed, and, though no vote was had, the expression was chiefly in favor of the last center set.

CASE 2. Orally presented by Mr. Skeels, and was that of a subdivision of Section six, having several peculiar features. The Society gave its attention chiefly to the subdivision of the three fractional quarters of the section, after the quarter lines are run; the question then being: "Shall each of these quarters be treated by itself and independent of all beyond its own boundaries."

Pending which Mr. Pearsons read the following letter from the commissioner of the general land office, bearing date Sept. 2, 1876:

SIR:—I am in receipt of your letter of the 21st ult. concerning subdivisions of fractional quarter-sections. In reply, I have to say that, upon the lines closing upon the north and west boundaries of a township, the quarter-section corners are established by the U. S. department surveyors at precisely forty chains to the N. or W. of the last interior section corner, and the excess or deficiency in the measurement is thrown on the outer tier of lots as per act of congress approved May 10, 1800.

In the subdivision of quarter-sections, the quarter-quarter corners are to be placed at points equidistant on straight lines between the section and quarter-section corners, and between the quarter-section corners and the common center of the section,—except on the last half-mile of the lines closing on the N. and W. boundary of a township, where they should be placed at twenty chains original measurement to the N. or W. of the quarter-section corners.

Very Respectfully,
J. A. WILLIAMSON,
Commissioner.

The following resolution was then introduced and passed, with one dissenting vote.

Resolved, That in subdividing sections, sub-quarter lines shall only be run across the quarter section they divide; and their termini shall be points on the section or quarter-section lines at distances between the corners which determine them, proportional to the original measurements.

The application of this resolution to the case in hand would produce an angle in the west sub-quarter line at its intersection with the east and west quarter line. Mr. Skeels, dissenting, said he hoped the resolution would not be adopted, believing it contrary to the United States laws, and in support of his position quoted from the manual by J. H. Hawes, 1868, as follows, pages 135–136.

It must be borne in mind that the boundaries of the public lands established by the government surveyors are unchangeable. * * * *

The following will enable the surveyor to divide the section into its legal subdivisions in conformity with the laws of congress:

No. 1. * * * It will be useless therefore, when called upon to subdivide a section where one of the original corners was established out of line or out of measurement, to attempt to make such a division as will give an equal area to even two of the subdivisions. It cannot be done without violating the rules prescribed by congress in such cases.

No. 2. (Refers to the re-establishing of corners.)

No. 3. The quarter-quarter corners not established by deputy surveyors MUST BE PLANTED EQUIDISTANT, AND ON LINE BETWEEN THE QUARTER POST AND THE SECTION CORNER.

No. 4. All the subdivisional lines of a section MUST BE STRAIGHT LINES, RUNNING FROM THE PROPER CORNER IN ONE EXTERIOR LINE TO ITS CORRESPONDING CORNER IN THE OPPOSITE BOUNDARY OF THE SECTION. THERE IS NO EXCEPTION TO THIS RULE.

Also on page 142 of the same manual, from the letter of June 11, 1864, by Commissioner Edmunds, the following:

All lines sub-dividing a section must be STRAIGHT LINES running THROUGH the section, from the corner in one boundary to its corresponding corner in the opposite boundary of said section.

CASE 3. By Mr. Caukin: Corner to section four and five on n. boundary, which is a correction parallel, is lost. U. S. field notes

give no distance to any other corner on the boundary. I ran a straight line from corner to four, five, eight and nine through ¼ post to four and five to the boundary, and established the corner at my intersection. Was that correct? Vote unanimous in the affirmative.

CASE 4. By Mr. Pettibone: As to the method of locating the n. w. and s. w. corner of section seven. In the case of the n. w. corner the principle would appear to be the same as in No. three, by Mr. Caukin. Owing to an impassable marsh no corner to six and seven on w. boundary was set by U. S. survey, but on the eastern portion the line was sufficiently marked by blazed trees so that it could be projected westward to the boundary. As to the s. w. corner, the U. S. field notes show it to have been duly set at an intersection. 5.90 chains north of the corner to twelve and thirteen, but no evidence of it is to be found on the ground. The eastern portion of the line between seven and eighteen is amply marked by blazed trees, but when projected westward makes an intersection only 1.30 chains north of corner to twelve and thirteen, instead of the 5.90.

Both questions were voted upon together, fourteen to nine in favor of projecting the lines westward to an intersection, and there establishing the corners.

CASE 5. By Mr. Mark: Similiar to No. three by Mr. Caukin, except that there was no monument by which the line could be projected. Answered to the effect that the line should be projected on an intermediate course between the lines east and west of the one in question, and corner established on the boundary accordingly.

Many other questions of practice were submitted orally and discussed, with how much of profit those present will judge. In this connection the reader is referred to the standing resolution as to the executive committee, and their remarks thereunder.

INSTRUMENTS.

Mr. Hodgman exhibited a home-made beam compass,—a rod of wood 3-16 inch square of any length, with a large needle at one end for the fixed point, and a large cork fitted to slide snugly along the rod and to carry an ordinary ruling pen.

Mr. Bailey explained his method of attaching a small telescope to his compass, making a serviceable substitute for a high priced transit at small cost.

Mr. Steele exhibited a steel tape manufactured by Mr. Hodgman of Traverse City. Discussion of chains *vs.* tape as a measuring instrument ensued, and resulted in the adoption of the following:

Resolved, That this association recommend the use of the steel tape as a more accurate instrument of measure than the chain.

STATE LINE BETWEEN MICHIGAN AND OHIO.

Mr. Mark of Hillsdale, asked the advice of the Society as to the proper method of re-establishing the corners marking this line, stating that many of them are lost, that the whole line is in danger, and gave details as to such of these points as have come under his observation. After discussion the question was disposed of by the adoption of the following:

WHEREAS, We have evidence that the State line forming the boundary between this State and the State of Ohio is disputed and is lost, or in danger of being lost; therefore,

Resolved, That we recommend to the Legislature that provisions be made for the appointment of a commission of competent surveyors, to act in concert with a like commission from the State of Ohio, to examine into and report on the condition of the boundary in question, to the end that it may be preserved and suitably perpetuated.

LEGISLATION.

Early in the session of the Society Messrs. Pearsons, Guild, Fessenden, Skeels and Bartholomew, were appointed to consider and report upon desired legislation. Later, to give the "county surveyor" fair representation, Messrs. Drew and F. Hodgman were added, making with Mr. Skeels, three county surveyors on the committee. The committee reported a measure to amend act 159 of 1877 so as to make the surveys contemplated thereby, a charge upon the lands concerned, and to repeal act 205 of 1879, which fixes the expense of such surveys on the county at large.

The committee also reported a measure to provide for organizing the surveying service of the State; to secure a uniformity of practice, use of standard measure, and for the more complete recording of surveys of a permanent nature.

These measures were carefully gone through with by the Society in discussion, variously amended, and referred to the committee to be presented to the legislature. At the close of the meeting, Mr. Skeels was replaced on the committee by Mr. Teed, on account of the former's necessary absence.

A NEW MONUMENT.

The Jackson Fire Clay Company exhibited specimens of a vitrified stone corner stake. The following correspondence covers all that need be given concerning it:

LANSING, Jan. 18, 1881.

SIR.—This Society at its last session passed this:

Resolved, That the secretary of this association be directed to ascertain the price at which the Jackson Fire Clay Company will furnish their corner stakes as here shown, in quantities of twenty and one hundred respectively, and that the secretary embody such information in his report.

I would add that the specimens shown were carefully examined by several of our leading members after the close of our meeting, who seemed to agree that a simple cylinder three by twelve to forty inches would be the most practical form for the stake, and they requested me to ascertain the price per foot of such simple cylinders in quantity not less than one hundred feet, cut in lengths to order, each stake to have a center indicated on one end by grooves crossed at right angles.

Objection was made to the enlarged head as rendering the stake more liable to disturbance by frost, and to the attachment of metallic characters indicating particular corners as adding largely to cost, with no practical benefit.

I was also requested to submit to you whether the stake might be rendered less liable to fracture from slight shocks by incorporating with the material a portion of cement or substance tending to toughen it. It was thought that added cost in this direction might be borne, and certainly so in preference to the head and letters.

The want is palpable for a corner monument of a form and material not commonly distributed, portable and cheap, and the opinion seemed to be that you are fairly meeting the first three of these points.

J. E. SHERMAN, *Secretary.*

JACKSON, Jan. 22, 1881.

SIR:—Replying to yours of the 18th, I have to say, that to meet the want referred to, we have manufactured a *vitrified stone stake* of the following description, dimensions and price:

It is manufactured from ground stone, soft shale, with a portion of fire clay, and the celebrated *Portage potter's clay* ground fine, rendering it homogeneous and uniform throughout; pressed through dies by powerful machinery; and after being subjected to a heat so intense that no iron or common clay will stand—in kilns constructed of fire brick—it makes a thoroughly vitrified *stone corner stake* that is warranted to be impervious to the action of frost, chemicals or acids, and of same material as our vitrified stone sewer pipe which has for many years stood the test under the most unfavorable conditions.

Although the stone may be broken by violence, like china, glass or stoneware, it is equally *imperishable*, and, being unlike any other stake in form or material, will always be recognized as a permanent landmark.

We are now making stakes of much finer and stronger material than those shown at your convention, and could increase the size if desired, but that would necessarily increase the cost in proportion to the weight.

Our present stake is a solid cylinder three inches in diameter, from one to three feet in length, with a cross (+) on one end. We also make them with a head, and place for fastening metallic figures to indicate township, range and section. These would be more expensive on account of cost of the figures.

We will furnish these stakes without heads at ten cents per lineal foot, cut in lengths of one, two or three feet, free on cars here; and if purchased in quantities sufficient to supply a whole county at once, would make a special discount of ten per cent.

Yours truly,
JACKSON FIRE CLAY CO.
Per C. H. HARRIS, *Gen. Supt.*

In this connection the following by Mr. Pearsons, on the value of wood as compared with stone for monuments or landmarks, is given:

Wood, though much used for the perpetuation of landmarks, has been looked upon as a frail and short-lived material, as a kind of compromise between necessity and utility. But from the results of some recent retracements of old lines, I am able to vindicate the merit of wood.

Through the kindness of Capt. H. W. Clarke of Syracuse, N. Y., who was surveyor in charge of the retracement of the boundary between the states of Pennsylvania and New York, I am in receipt of his report of two seasons' work, embracing the retracements of some two hundred and ten miles of the boundary supposed to be on the parallel of 42° n., together with some nineteen miles of the meridian boundary on the west side of the state of New York.

On the eastern portion of this parallel, Mr. Clarke retraced one hundred and nineteen miles in the year 1877. In this distance, including the initial monument, latitude, and intermediate milestones, one hundred and thirty-two monuments of stone were known to have been set during the original survey in 1786 and 1787. Of these he found only fifty-five evidently in place, thus showing a loss of over fifty-eight per cent. in about ninety-one years.

On the western part of the boundary, in 1878, the fatality of landmarks was even greater, it being about sixty-five per cent. Of the monuments out of place, a number was found and recognized by the marks on them, while others were totally lost- fire and the plow being their chief enemy.

On the meridian boundary, on the west of New York, Mr. Clarke found some nineteen miles of line marked originally by twenty monuments—fourteen of stone and six of wood. Of these, *two stones* were found *in place*, and one stone was out of place and place lost, while eight stones with their places were lost, and one of the stones in place was broken.

Of the six posts originally set, two were found in place, though rotted off at the ground and fallen over, their places being identified by the "rotten remains" in the ground. One of these posts was a chestnut, about six inches square; manner of setting not specified. The other was a cherry set in pile of small stones; size of post not specified. One post was replaced a few years ago with a stone, and three others with their places were totally lost.

In this history, the wooden monument, it is seen, has established for itself a creditable record; so that henceforth, in localities where others are impracticable, we need not be afraid to look with favor to a good post *set deep* in the ground, and surrounded with *stones, lime, broken brick*, or other matter foreign to that in which the pit for the post is made.

PERSONAL.

Prof. Davis and Messrs. Caukin, Stage, Strudwick, M. S. Cook and Todd, were detained at home by sickness; and Messrs. Arnold, Pierce, Vincent, E. C. Smith, Beden Watkins, A. H. Palmer, Teller, White, F. A. Palmer, Sanderson, Britt, Dixon, Cummings, Davidson, Martin, Gillette, R. Smith, Terry and others, by business.

The thanks of the Society and thirty dollars from its funds were voted the secretary for services rendered. The vote of thanks is gratefully accepted; but the money will be needed for society purposes during the current year, and the secretary begs leave to so devote it.

PAPERS AND COMMUNICATIONS.

The papers read by Judge Cooley, Prof. Greene, and Messrs. Bartholomew and Hodgman were but little discussed, and call for no comment in this report. All were listened to with the utmost interest, and the thanks voted each of them was not merely formal, but sincere, and might be taken as indicating the confidence of those present that the Society is working in the direction of actual accomplishment, and that individual effort is felt and appreciated.

The expected paper by Mr. A. D. Waddell, of Livingston county, was not presented, on account of his serious illness. The Society, by resolution, requested him to allow the paper to be published herewith. In answer, Mr. Waddell expresses his interest in our work, his disappointment at being unable to be present at our meeting, and hoping to be with us next year, desires to read his paper then.

Communications from Messrs. M. S. Cook, H. Strudwick, Isaac Teller, N. E. Britt, and A. J. Pierce were received and read.

THE JUDICIAL FUNCTIONS OF SURVEYORS.

BY JUSTICE COOLEY OF THE MICHIGAN SUPREME COURT.

When a man has had a training in one of the exact sciences where every problem within its purview is supposed to be susceptible of accurate solution, he is likely to be not a little impatient when he is told that, under some circumstances, he must recognize inaccuracies, and govern his actions by facts which lead him away from the results which theoretically he ought to teach. Observation warrants us in saying that this remark may frequently be made of surveyors.

In the State of Michigan all our lands are supposed to have been surveyed once or more, and permanent monuments fixed to determine the boundaries of those who should become proprietors. The United States as original owner, caused them all to be surveyed once by sworn officers, and as the plan of subdivision was simple, and was uniform over a large extent of territory, there should have been, with due care, few or no mistakes; and long rows of monuments should have been perfect guides to the place of any one that chanced to be missing. The truth unfortunately is that the lines were very carelessly run, the monuments inaccurately placed; and, as the recorded witnesses to these were many times wanting in permanancy, it is often the case that when the monument was not correctly placed, it is impossible to determine by the record with the aid of anything on the ground, where it was located. The incorrect record of course becomes worse than useless where the witnesses it refers to have disappeared.

It is, perhaps, generally supposed that our town plats were more accurately surveyed, as indeed they should have been, for in general there can have been no difficulty in making them sufficiently perfect for all practical purposes. Many of them, however, were laid out in the woods; some of them by proprietors themselves, without either chain or compass, and some by imperfectly trained surveyors, who, when land was cheap, did not appreciate the importance of having correct lines to determine boundaries when land should become dear. The fact probably is that town surveys are quite as inaccurate as those made under authority of the general government.

It is now upwards of fifty years since the major part of the public surveys in what is now the State of Michigan were made under authority of the United States. Of the lands south of Lansing, it is now forty years since the major part were sold, and the work of improvement begun. A generation has passed away since they were converted into cultivated farms, and few if any of the original corner and quarter stakes now remain.

The corner and quarter stakes were often nothing but green sticks driven into the ground. Stones might be put around or over these if they were handy, but often they were not, and the witness trees must be relied upon after the stake was gone. Too often the first settlers were

careless in fixing their lines with accuracy while monuments remained, and an irregular brush fence, or something equally untrustworthy, may have been relied upon to keep in mind where the blazed line once was. A fire running through this might sweep it away, and if nothing was substituted in its place, the adjoining proprietors might in a few years be found disputing over their lines, and perhaps rushing into litigation, as soon as they had occasion to cultivate the land along the boundary.

If now the disputing parties call in a surveyor, it is not likely that any one summoned would doubt or question that his duty was to find, if possible, the place of the original stakes which determined the boundary line between the proprietors. However erroneous may have been the original survey, the monuments that were set must nevertheless govern, even though the effect be to make one half-quarter section ninety acres and the one adjoining seventy; for parties buy, or are supposed to buy in reference to these monuments, and are entitled to what is within their lines, and no more, be it more or less. While the witness-trees remain, there can generally be no difficulty in determining the locality of the stakes.

When the witness-trees are gone, so that there is no longer record evidence of the monuments, it is remarkable how many there are who mistake altogether the duty that now devolves upon the surveyor. It is by no means uncommon that we find men, whose theoretical education is thought to make them experts, who think that when the monuments are gone, the only thing to be done is to place new monuments where the old ones should have been, and would have been if placed correctly. This is a serious mistake. The problem is now the same that it was before: To ascertain by the best lights of which the case admits, where the original lines were. The mistake above alluded to, is supposed to have found expression in our legislation; though it is possible that the real intent of the act to which we shall refer is not what is commonly supposed.

An act passed in 1869, Complied Laws § 593, amending the laws respecting the duties and powers of county surveyors, after providing for the case of corners which can be identified by the original field notes or other unquestionable testimony, directs as follows:

"*Second.* Extinct, interior section corners must be re-established at the intersection of two right lines joining the nearest known points on the original section lines east and west and north and south of it.

Third. Any extinct quarter-section corner, except on fractional lines, must be re-established equidistant and in a right line between the section corners; in all other cases at its proportionate distance between the nearest original corners on the same line."

The corners thus determined, the surveyors are required to perpetuate by noting bearing trees when timber is near.

To estimate properly this legislation, we must start with the admitted and unquestionable fact that each purchaser from government bought such land as was within the original boundaries, and unquestionably owned it up to the time when the monuments became extinct. If the monument was set for an interior section corner, but did not happen to be "at the intersection of two right lines joining the nearest known points on the original section lines east and west and north and south of it," it nevertheless determined the extent of his possessions, and he gained or lost according as the mistake did or did not favor him

It will probably be admitted that no man loses title to his land or any part thereof, merely because the evidence becomes lost or uncertain. It may become more difficult for him to establish it as against an adverse claimant, but theoretically the right remains; and it remains as a potential fact so long as he can present better evidence than any other person.

And it may often happen that notwithstanding the loss of all trace of a section corner or quarter-stake, there will still be evidence from which any surveyor will be able to determine with almost absolute certainty where the original boundary was between the government subdivisions.

There are two senses in which the word extinct may be used in this connection: One the sense of physical disappearance: the other the sense of loss of all reliable evidence. If the statute speaks of extinct corners in the former sense, it is plain that a serious mistake was made in supposing that surveyors could be clothed with authority to establish new corners by an arbitrary rule in such cases. As well might the statute declare that if a man loses his deed, he shall lose his land altogether.

But if by extinct corner is meant one in respect to the actual location of which all reliable evidence is lost, then the following remarks are pertinent.

1. There would undoubtedly be a presumption in such a case, that the corner was correctly fixed by the government surveyor where the field notes indicated it to be.

2. But this is only a presumption, and may be overcome by any satisfactory evidence showing that in fact it was placed elsewhere.

3. No statute can confer upon a county surveyor the power to "establish" corners, and thereby bind the parties concerned. Nor is this a question merely of conflict between State and federal law; it is a question of property right. The original surveys must govern, and the laws under which they were made must govern, because the land was bought in reference to them; and any legislation, whether state or federal, that should have the effect to change these, would be inoperative, because disturbing vested rights.

4. In any case of disputed lines, unless the parties concerned settle the controversy by agreement, the determination of it is necessarily a judicial act, and it must proceed upon evidence, and give full opportunity for a hearing. No arbitrary rules of survey or of evidence can be laid down whereby it can be adjudged.

The general duty of a surveyor in such a case is plain enough. He is not to assume that a monument is lost until after he has thoroughly sifted the evidence, and found himself unable to trace it. Even then he should hesitate long before doing anything to the disturbance of settled possessions. Occupation, especially if long continued, often affords very satisfactory evidence of the original boundary when no other is attainable; and the surveyor should inquire when it originated, how, and why the lines were then located as they were, and whether a claim of title has always accompanied the possession, and give all the facts due force as evidence. Unfortunately it is known that surveyors sometimes, in supposed obedience to the State statue, disregard all evidence of occupation and claim of title, and plunge whole neighborhoods into quarrels and litigation by assuming to "establish" corners at points with which the previous occupation cannot harmonize. It is often the case that where one or more corners are found to be extinct, all parties concerned have acquiesced in lines which were traced by the guidance of some other corner or landmark, which may or may not have been trustworthy; but to bring these lines into discredit when the people concerned do not question them not only breeds trouble in the neighborhood, but it must often subject the surveyor himself to annoyance and perhaps discredit, since in a legal controversy the law as well as common sense must declare that a supposed boundary line long acquiesced in, is better evidence of where a line should be than any survey made after the original monuments have disappeared *Stewart vs. Carlton*, 31 Michigan Reports, 270; *Diehl vs. Zanger*, 39 Michigan Reports, 601 And county surveyors, no more than any others, can conclude parties by their surveys.

The mischiefs of overlooking the facts of possession most often appear in cities and villages. In towns the block and lot stakes soon disappear; there are no witness trees, and no monuments to govern, except such as have been put in their places, or where their places were supposed to be. The streets are likely to be soon marked off by fences, and the lots in a block will be measured off from these, without looking farther. Now it may perhaps be known in a particular case that a certain monument still remaining was the starting point in the original survey of the town plat; or a surveyor settling in the town may take some central point as the point of departure in his surveys, and assuming the original plat to be accurate, he will then undertake to find all streets and other lots by course and distance according to the plat, measuring and estimating from his point of departure. This procedure might unsettle every line and every monument existing by acquiesence in the town; it would be very likely to change the lines of streets, and raise controversies everywhere. Yet this is what is sometimes done; the surveyor himself being the first person to raise the disturbing questions.

Suppose, for example, a particular village street has been located by acquiesence and used for many years, and the proprietors in a certain block have laid off their lots in reference to this practical location. Two lot owners quarrel, and one of them calls in a surveyor that he may make sure his neighbor shall not get an inch of land from him. This surveyor undertakes to make his survey accurate, whether the original was so or not, and the first result is, he notifies the lot owners that there is error in the street line, and that all fences should be moved say, one foot to the east. Perhaps he goes on to drive stakes through the block according to this conclusion. Of course, if he is right in doing this, all lines in the village will be unsettled; but we will limit our attention to the single block. It is not likely that the lot owners generally will allow the new survey to unsettle their possessions, but there is always a probability of finding some one disposed to do so. We shall then have a lawsuit; and with what result?

It is a common error that lines do not become fixed by acquiescence in a less time than twenty years. In fact, by statute, road lines may become conclusively fixed in ten years; and there is no particular time that shall be required to conclude private owners, where it appears that they have accepted a particular line as their boundary, and all concerned have cultivated and claimed up to it. Public policy requires that such lines be not lightly disturbed, or disturbed at all after the lapse of any considerable time. The litigant therefore, who in such a case pins his faith on the surveyor, is likely to suffer for his reliance, and the surveyor himself to be mortified by a result that seems to impeach his judgment.

Of course nothing in what has been said can require a surveyor to conceal his own judgment, or to report the facts one way when he believes them to be another. He has no right to mislead, and he may rightfully express his opinion that an original monument was at one place, when at the same time he is satisfied that acquiescence has fixed the rights of parties as if it were at another. But he would do mischief if he were to attempt to "establish" monuments which he knew would tend to disturb settled rights; the farthest he has to go as an officer of the law, is to express his opinion where the monument should be, at the same time that he imparts the information to those who employ him, and who might otherwise be misled, that the same authority that makes him an officer, and entrusts him to make surveys, also allows parties to settle their own boundary lines, and considers acquiescence in a particular line or monument, for any considerable period, as strong, if not conclusive evidence of such settlement. The peace of the community absolutely requires this rule. It is not long since, that in one of the leading cities

of the State an attempt was made to move houses two or three rods into a street, on the ground that a survey under which the street had been located for many years, had been found on a more recent survey to be erroneous.

From the forgoing it will appear that the duty of the surveyor where boundaries are in dispute must be varied by the circumstances. 1. He is to search for original monuments, or for the places where they were originally located, and allow these to control if he finds them, unless he has reason to believe that agreements of the parties, express or implied, have rendered them unimportant. By monuments in the case of government surveys we mean of course the corner and quarter stakes; blazed lines or marked trees on the lines are not monuments; they are merely guides or finger posts, if we may use the expression, to inform us with more or less accuracy where the monuments may be found. 2. If the original monuments are no longer discoverable, the question of location becomes one of evidence merely. It is merely idle for any State statute to direct a surveyor to locate or "establish" a corner, as the place of the original monument, according to some inflexible rule. The surveyor on the other hand must inquire into all the facts; giving due prominence to the acts of parties concerned, and always keeping in mind, *first*, that neither his opinion nor his survey can be conclusive upon parties concerned; and, *second*, that courts and jurors may be required to follow after the surveyor over the same ground, and that it is exceedingly desirable that he govern his action by the same lights and the same rules that will govern theirs.

It is always possible when corners are extinct that the surveyor may usefully act as a mediator between parties, and assist in preventing legal controversies by settling doubtful lines. Unless he is made for this purpose an arbitrator by legal submission, the parties, of course, even if they consent to follow his judgment, cannot on the basis of mere consent, be compelled to do so; but if he brings about an agreement, and then carry it into effect by actually conforming their occupation to his lines, the action will conclude them. Of course, it is desirable that all such agreements be reduced to writing: but this is not absolutely indispensable if they are carried into effect without.

Meander lines. The subject to which allusion will now be made is taken up with some reluctance, because it is believed the general rules are familiar. Nevertheless it is often found that surveyors misapprehend them, or err in their application, and as other interesting topics are somewhat connected with this, a little time devoted to it will not be altogether lost. The subject is that of meander lines. These are lines traced along the shores of lakes, ponds and considerable rivers as the measures of quantity when sections are made fractional by such waters. These have determined the price to be paid when government lands were bought, and perhaps the impression still lingers in some minds that the meander lines are boundary lines, and all in front of them remains unsold. Of course this is erroneous. There was never any doubt that, except on the large navigable rivers, the boundary of the owners of the banks is the middle line of the river; and while some courts have held that this was the rule on all fresh water streams, large and small, others have held to the doctrine that the title to the bed of the stream below low water mark is in the State, while conceding to the owners of the banks all riparian rights. The practical difference is not very important. In this State the rule that the center line is the boundary line is applied to all our great rivers, including the Detroit, varied somewhat by the circumstance of there being a distinct channel for navigation in some cases with the stream in the main shallow, and also sometimes by the existence of islands.

The troublesome questions for surveyors present themselves when the boundary line between two contiguous estates is to be continued from the meander line to the center line of the river. Of course the original survey supposes that each purchaser of land on the stream has a water front of the length shown by the field notes; and it is presumable that he bought this particular land because of that fact. In many cases it now happens that the meander line is left some distance from the shore by the gradual change of the course of the stream, or diminution of the flow of water. Now the dividing line between two government subdivisions might strike the meander lines at right angles, or obliquely; and in some cases, if it were continued in the same direction to the center line of the river, might cut off from the water one of the subdivisions entirely, or at least cut it off from any privilege of navigation, or other valuable use of the water, while the other might have a water front much greater than the length of a line crossing it at right angles to its side lines. The effect might be that of two government subdivisions of equal size and cost, one would be of very great value as water-front property, and the other comparatively valueless. A rule which would produce this result would not be just, and it has not been recognized in the law.

Nevertheless, it is not easy to determine what ought to be the correct rule for every case. If the river has a straight course, or one nearly so, every man's equities will be preserved by this rule: Extend the line of division between the two parcels from the meander line to the center line of the river, as nearly as possible at right angles to the general course of the river at that point. This will preserve to each man the water-front which the field notes indicated, except as changes in the water may have affected it, and the only inconvenience will be that the division line between different subdivisions is likely to be more or less deflected where it strikes the meander line.

This is the legal rule, and it is not limited to government surveys, but applies as well to water lots which appear as such on town plats. *Bay City Gas Light Co. v. The Industrial Works*, 28 Mich. Reports, 182. It often happens, therefore, that the lines of city lots bounded on navigable streams are deflected as they strike the bank; or the line where the bank was when the town was first laid out.

When the stream is very crooked, and especially if there are short bends, so that the foregoing rule is incapable of strict application, it is sometimes very difficult to determine what shall be done, and in many cases the surveyor may be under the necessity of working out a rule for himself. Of course his action cannot be conclusive; but if he adopts one that follows as near as the circumstances will admit, the general rule above indicated, so as to divide as near as may be the bed of the stream among the adjoining owners in proportion to their lines upon the shore, his division, being that of an expert, made upon the ground and with all available lights, is likely to be adopted as law for the case. Judicial decisions, into which the surveyor would find it prudent to look under such circumstances, will throw light upon his duties, and may constitute a sufficient guide when peculiar cases arise. Each riparian lot owner ought to have a line on the legal boundary, namely, the center line of the stream, proportioned to the length of his line on the shore; and the problem in each case is, how this is to be given him. Alluvion, when a river imperceptibly changes its course, will be apportioned by the same rules.

The existence of islands in a stream when the middle line constitutes a boundary, will not affect the apportionment unless the islands were surveyed out as government subdivisions in the original admeasurement. Wherever that was the case, the purchaser of the island divides the bed

of the stream on each side with the owner of the bank, and his rights also extend above and below the solid ground, and are limited by the peculiarities of the bed and the channel. If an island was not surveyed as a government subdivision previous to the sale of the bank, it is of course impossible to do so for the purpose of government sale afterwards, for the reason that the rights of the bank owners are fixed by their purchase: when making that, they have a right to understand that all land between the meander lines, not separately surveyed and sold, will pass with the shore in the government sale; and having this right, anything which their purchase would include under it cannot afterwards be taken from them. It is believed, however, that the federal courts would not recognize the applicability of this rule to large navigable rivers, such as those uniting the great lakes.

On all the little lakes of the State which are mere expansions near their mouths of the rivers passing through them—such as the Muskegon, Pere Marquette and Manistee—the same rule of bed ownership has been judicially applied that is applied to the rivers themselves; and the division lines are extended under the water in the same way. *Rice v. Ruddiman*, 10 Mich., 125. If such a lake were circular, the lines would converge to the center; if oblong or irregular, there might be a line in the middle on which they would terminate, whose course would bear some relation to that of the shore. But it can seldom be important to follow the division line very far under the water, since all private rights are subject to the public rights of navigation and other use, and any private use of the lands inconsistent with these would be a nuisance, and punishable as such. It is sometimes important, however, to run the lines out for some considerable distance, in order to determine where one may lawfully moor vessels or rafts for the winter, or cut ice. The ice crop that forms over a man's land of course belongs to him. *Lorman v. Benson*, 8 Mich., 18; *Peoples' Ice Co. v. Steamer Excelsior*, recently decided.

What is said above will show how unfounded is the notion, which is sometimes advanced, that a riparian proprietor on a meandered river may lawfully raise the water in the stream without liability to the proprietors above, provided he does not raise it so that it overflows the meander line. The real fact is that the meander line has nothing to do with such a case, and an action will lie whenever he sets back the water upon the proprietor above, whether the overflow be below the meander lines or above them.

As regards the lakes and ponds of the State, one may easily raise questions that it would be impossible for him to settle. Let us suggest a few questions, some of which are easily answered, and some not:

1. To whom belongs the land under these bodies of water, where they are not mere expansions of a stream flowing through them?
2. What public rights exist in them?
3. If there are islands in them which were not surveyed out and sold by the United States, can this be done now?

Others will be suggested by the answers given to these.

It seems obvious that the rules of private ownership which are applied to rivers cannot be applied to the great lakes. Perhaps it should be held that the boundary is at low water mark, but improvements beyond this would only become unlawful when they became nuisances. Islands in the great lakes would belong to the United States until sold, and might be surveyed and measured for sale at any time. The right to take fish in the lakes, or to cut ice, is public like the right of navigation, but it is to be exercised in such manner as not to interfere with the rights of shore owners. But so far as these public rights can be the subject of ownership, they belong to the State, not to the United States; and

so, it is believed, does the bed of a lake also. *Pollard v. Hagan*, 3 Howard's United State's Reports. But such rights are not generally considered proper subjects of sale, but like the right to make use of the public highways, they are held by the State in trust for all the people.

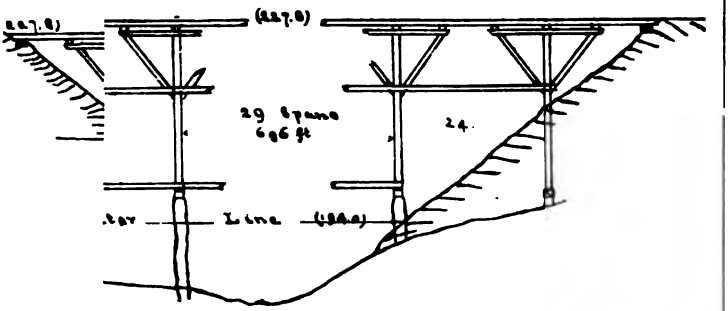
What is said of the large lakes may perhaps be said also of many of the interior lakes of the State; such, for example, as Houghton, Higgins, Cheboygan, Burt's, Mullet, Whitmore, and many others. But there are many little lakes or ponds which are gradually disappearing, and the shore proprietorship advances *pari passu* as the waters recede. If these are of any considerable size--say, even a mile across—there may be questions of conflicting rights which no adjudication hitherto made could settle. Let any surveyor, for example, take the case of a pond of irregular form, occupying a mile square or more of territory, and undertake to determine the rights of the shore proprietors to its bed when it shall totally disappear, and he will find he is in the midst of problems such as probably he has never grappled with, or reflected upon before. But the general rules for the extension of shore lines, which have already been laid down, should govern such cases, or at least should serve as guides in their settlement.

Where a pond is so small as to be included within the lines of a private purchase from the government, it is not believed the public have any rights in it whatever. Where it is not so included, it is believed they have rights of fishery, rights to take ice and water, and rights of navigation for business or pleasure. This is the common belief, and probably the just one. Shore rights must not be so exercised as to disturb these, and the states may pass all proper laws for their protection. It would be easy with suitable legislation to preserve these little bodies of water as permanent places of resort for the pleasure and recreation of the people and there ought to be such legislation.

If the State should be recognized as owner of the beds of these small lakes and ponds, it would not be owner for the purpose of selling. It would be owner only as trustee for the public use; and a sale would be inconsistent with the right of the bank owners to make use of the water in its natural condition in connection with their estates. Some of them might be made salable lands by draining; but the State could not drain, even for this purpose, against the will of the shore owners, unless their rights were appropriated and paid for.

Upon many questions that might arise between the State as owner of the bed of a little lake and the shore owners, it would be presumptuous to express an opinion now, and fortunately the occasion does not require it.

I have thus indicated a few of the questions with which surveyors may now and then have occasion to deal, and to which they should bring good sense and sound judgment. Surveyors are not and cannot be judicial officers, but in a great many cases they act in a *quasi* judicial capacity with the acquiescence of parties concerned; and it is important for them to know by what rules they are to be guided in the discharge of their judicial functions. What I have said cannot contribute much to their enlightenment, but I trust will not be wholly without value.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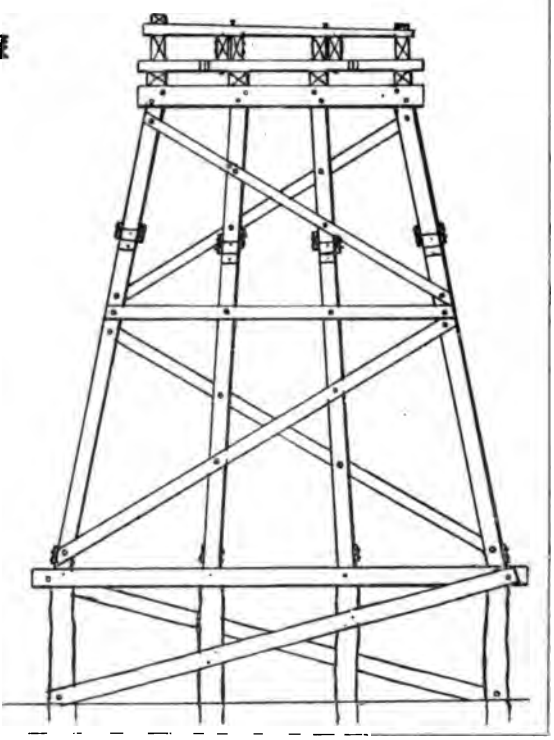
24
Line



WOODEN TRESTLE BRIDGE OVER THE HURON RIVER, AT ANN ARBOR, MICH*

BY PROF. CHARLES E. GREENE, OF MICHIGAN UNIVERSITY.

This bridge, built during the past season, carries the Toledo, Ann Arbor and Grand Trunk Railway over the Michigan Central Railroad and the Huron River. It describes a curve of 1433 feet radius, is 980 feet long, and the rails are 33 feet above the water in the mill-pond where the crossing is made. The whole bridge is on a level grade.

At its southerly end, this bridge crosses a highway; with a clear span of forty feet, and is supported on two timber piers, each five feet wide, set on a skew of thirty degrees. The depth of the truss at its middle is four feet, and the head-room beneath is between thirteen and fourteen feet. Next, it crosses a side track of the T., A. A. & G. T. R., and soon reaches the M. C. R. R. yard. Here the bents are placed on a skew of from thirteen to fifteen degrees. Two openings of fourteen feet are left for possible side tracks, and the three tracks of the M. C. R. R. are passed by an opening of fifteen and one-half feet and a truss span of thirty feet. Twenty and one-half feet in the clear above the rails are here given. The portion over the river, 774 feet long, has the bents set radially to the curve, at a uniform distance apart of twenty-four feet. The side elevation of part of the bridge is shown in the accompanying sketch, and also a view of one of the main bents.

All of the trestle bents are supported on large white-oak piles, four to each bent, on land and in shoal water, and six piles to each bent in deeper water. In addition, two piles are driven in each row in the mid-stream portion to serve as ice-breakers. The greatest depth of water is thirteen feet. The bottom is compact gravel and sand, with some stones, which interfered a little with the pile-driving. All piles were driven to refusal, with an 1800 pound hammer, and the general penetration was from eight to ten feet. They were cut off about four feet above the water, and capped with a 12x14 white oak stick, secured by tenon, mortise and wedge. The feet of the trestle posts are tenoned into the pile caps and pinned, a drip being bored in the mortise. No tenons and mortises are found in the remainder of the superstructure, but the timbers are gained and bolted. Special castings are used at the feet of the braces, to avoid cutting the posts.

The deck of the bridge is nearly twelve feet wide inside the guards, which are gained and bolted six inches from the end of the ties. The ties are 6x8 in average section, fourteen feet long, and spaced fourteen

*The working drawings were exhibited at the convention, and some details of design and construction were then pointed out, which are here necessarily omitted.

inches between centres; they are cut tapering, eight inches thick at one end and four inches thick at the other, to give a cant to the rails. The stringers are six in number, all 8x14, supported every eight feet and breaking joints in general; two are packed together under each rail and one over each outside post. The transverse bearing beams rest on the bolsters, which are four in number one over each post, and supported also by braces. Lateral bracing just below the stringers takes up the centrifugal force of the train and resists wind pressure. The bridge is designed to carry an engine safely when derailed, and close to the guard-rail. It is believed that the effect of any concentrated weight on a cross-bearer is distributed by this design over several points.

With the exception of the piles, pile caps, ties, and guard-rails, the bridge is built of white pine. The pile-driving was done at a fixed price per pile; all other work was done by the day. All joints were painted before the timbers were put together. Work was begun in the latter part of August, and the bridge was practically completed early in November, 1880, the actual working time being very nearly sixty days. The shore bents were raised by a gin-pole, and those in the river by a traveling frame, running on ways laid on the ends of the pile-caps.

The following facts should be noticed in comparing the cost of this bridge with that of other structures: The city of Ann Arbor prescribed that thirteen and one-half feet headway should be given over the street, that the span should be forty feet, and that the piers should be parallel with the street. Four feet only remained from the top of the stringers to the bottom of the truss. In order to retain the width of the deck and to avoid the use of heavy floor timbers, it was thought best to place the trusses below grade, to introduce four of them, and thus render the support of the stringers uniform throughout the bridge. Hence arose the peculiar truss used, and the skew framing increased materially the bill for labor. The trestle bents in the M. C. R. R. yards were also placed on a skew. All of the piles, and most of the timber for 770 linear feet of the bridge was carried by hand across the three tracks of the M. C. R. R. Co., because that company declined to allow any materials to be rolled or hauled across their tracks; the transportation in this way of large oak piles thirty feet long, and pine timber of the scantling here employed, often interrupted by trains, made a large item in the pay-roll. There were also some delays in procuring timber, which hindered the efficient working of the crew.

The bridge was designed and superintended by the writer, as engineer of the T. A. A. & G. T. R'y; the field-work was in charge of Chas. L. Baker, division engineer; and the framing and erection was directed by Mr. Henry Smith, roadmaster of the same road.

The itemized cost of the bridge was as follows:

	Length	Pine at $18 per M.	Oak at $15 per M.	Wrought Iron at 3½c. per lb.	Cast Iron at 3c. per lb.	Totals.
Main-st.truss,etc	66 ft.	16,582 ft.=$298.48	4,906 ft.=$73.59	3,110.7 lbs.=$116.65	3,773.3 lbs.= $113.20	$601.92
Main-st. to river.	140 ft.	26,923 ft.= 484.61	10,192 ft.= 152.88	5,603.3 lbs. = 210.12	6,027.2 lbs.= 180.82	1,028.43
River spans.....	774 ft.	170,831 ft.=3,074.96	60,196 ft.= 902.94	12,163.8 lbs.= 456.14	34,424 8 lbs.=1,032.74	5,466.78
		214,336ft.=$3,858.05	75,294 ft.=$1,129.41	20,877.8 lbs.=$782.91	44,225.3 lbs.=$1,326.76	7,097.13
Extra timber.....		101.31		27.10	9.51	137.92
Total.....						$7,235.05

Superstructure.....	$7,235.05
Piles, 218, 30 feet long at 11 cents per foot.....	719.40
Driving 218 piles at $2.25.....	490.50
Labor.....	3,648.61
Total cost.....	$12,093.56

Cost per foot, $12.34.
Cost of materials above piles: Main St., $9.12 per foot; M C. R. R. yard, $7.34 per foot; river, $7.06 per foot.

THE SURVEYOR IN PERSPECTIVE.

BY H. D. BARTHOLOMEW, CITY ENGINEER, LANSING.

Mr. President and Gentlemen of the Association:

At the request of your Secretary I have spent what little time I could command in looking up the status of the profession, in the various States of the Union, and the proceedings of the several surveyors' and engineers' conventions held during late years, as a preparatory study in determining what legislation we should ask for in Michigan.

Out of the thirty-eight States in the Union, in ten the surveyor is not a public officer; to-wit: the six New England States with Delaware, New York, New Jersey and Illinois, which abolished the office of county surveyor at the last election.

In eleven States he is a constitutional officer, viz.: Arkansas, Colorado, Indiana, Kentucky, Maryland, Mississippi, North Carolina, Oregon, Pennsylvania, Virgina and West Virgina.

In sixteen States he is a legal officer, a creature of the Legislature, as follows: Alabama, California, Florida, Georgia, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Nevada, Ohio, South Carolina, Tennessee, Texas and Wisconsin.

In one his status is doubtful,—Michigan.

In three States the certificates of the county surveyor only are *prima facie* evidence of the facts stated, in surveying and sub-dividing land, and laying out towns and additions, to-wit: Arkansas, California and Florida.

In five States the surveyor has charge of the unoccupied State lands lying in his county, viz.: Georgia, Louisiana, Maryland, North Carolina and South Carolina. In thirteen States no person is named for surveying and sub-dividing land, and laying out towns and additions, and it would seem that it is free to all, being the five States in which the county surveyors have charge of the State lands, with Alabama, Kansas, Kentucky, Mississippi, Nevada, Pennsylvania, Tennessee and Texas.

In the other twenty-two States the business is free to all competent surveyors.

To return to the doubtful State, our Michigan—the following are the facts as I find them:

Under the constitution of 1835, he was a constitutional officer. See section 4 of article 7 of that instrument.

The first State law on the subject is found in the Revised Statutes of 1838, sections 62 to 70 of chapter 3, title 3, which is practically the territorial law of April 23, 1833.

Michigan was set apart as a territory January 22, 1805. In 1806 we find the first law concerning a surveyor, passed September 14—a single

section. His duties were increased by the act of May 18, 1807, in which he is directed to mark the places for shade trees in Detroit, by driving stakes.

On June 8, 1819, we find a fuller, more complete law, entitled, "An act to provide for the appointment, to define the duties, and to fix the compensation of the surveyor of Michigan and his deputies." This act provides for a surveyor with any number of deputies, and repeals the former act. This act was amended March 2, 1821, in several points. By one provision at least one deputy was to be appointed in each county. July 31, 1830, the law was revised. The surveyor for Michigan was done away with and a district surveyor appointed by the governor for each county. On April 23, 1833, the law was again revised, the governor appointing with the advice of the council, and the term of the surveyor's office was for four years.

The revised statutes of 1838 was amended by act 54 of the laws of 1845, declaring that the records belonged to the office.

The laws were again revised in 1846. See sections 95 to 106 of chapter 14, title 3, where the old territorial title is changed to county surveyor in every section, except 97 and 105, where the word county is omitted.

In 1850 a new constitution was adopted. In the debates of the convention that framed that instrument the words county surveyor appeared only twice. First on page 315, of debates, July 9, 1850, in the committee county surveyor is reported with other county officers. Second, on page 518 of the debates, July 22, 1850, in the convention, the section came up for passage. Mr. Daniels of Lenawee moved that county surveyor be stricken out, as the office was unnecessary, and often quite inconvenient for the people, citing New York State. The motion was carried, the section as amended passed. See section 3, article 10, of present constitution. For provisions to adapt the laws relating to county surveyors to the new constitution, see schedule, section 1, 8, 13 and 14.

Section 2, of act 172 of laws of 1851, amends section 15 of chapter 15, title 3, of the revised statutes of 1846, stating who can fill a vacancy in the office of county surveyor, now found in section 15 of chapter 11, compiled laws. No other act of the legislature from 1846 to 1861 contains the words county surveyor.

In 1857 the laws were compiled under section 15 of article 18 of the constitution when sections 95 to 106 of chapter 14, title 3, of the revised statutes of 1846, were copied verbatim into sections 95 to 106 of chapter 10, compiled laws.

The legislature of 1861, by act 260, amended sections 100 and 106 of chapter 10, compiled laws, requiring the county surveyor to make a fuller record and modifying his fees.

In 1865 the legislature, by act 223, amended section 103 of chapter 10, compiled laws, giving the county surveyor fuller instructions as to corners.

Again, in 1867, by act 108, they amended section 106 of chapter 10, compiled laws, increasing the county surveyor's per diem.

In 1869 by act 140, they repealed act 260 of 1861, and act 108 of 1867, and re-amended sections 100, 102, 103, 105 and 106 of chapter 10, compiled laws, leaving the law as we have it in sections 95 to 106 of chapter 10, compiled laws of 1871, for since that date the legislature has not mentioned the county surveyor.

You will notice that the legislature of 1869 did not repeal act 223 of 1865, but re-amended the same section, and the compiler on the principle that the last amendment is binding, did not copy any of the law of 1865.

In section 6 of chapter 1 is the only other place where county surveyor appears in the compiled laws, where he is declared in common with other county officers entitled to a copy of the laws, which was also copied from the revised statutes of 1846, section 6 of chapter 1, title 1.

Referring to the compilation of 1871, we find county surveyor mentioned in only three distinct places: In section 6 of chapter 1, granting him a copy of the laws; in sections 95 to 106 of chapter 10, defining his duties, privileges and compensation, and in section 15 of chapter 11, stating who can fill a vacancy in the office.

For our purpose we need only examine sections 95 to 106 of chapter 10.

Sections 95 and 96 are technical. Section 97 provides that the certificate of the surveyor, or his deputies, or any survey made by him of any lands in the county shall be presumptive evidence of the facts therein contained. In the original law of 1838, it was competent and presumptive evidence. In the territorial law it was legal evidence. You will notice that the word county is not prefixed to surveyor, this having been copied from the territorial law as before remarked. But the real question on this section is, does it give any exclusive privileges to the county surveyor? Is not the certificate of any well-known surveyor presumptive evidence of the facts set forth therein concerning his surveys?

Section 98 provides that the county surveyor shall make such surveys as may be required of him by order of any court, that is, any survey the parties interested do not, or cannot find any other surveyor to make under sections 11, 12 and 13 of chapter 200, compiled laws, or by application of any person therefor, who does not choose to employ any other surveyor.

Section 99 is technical. Section 100 gives the county surveyor an advantage over his brethren in regard to the county records.

Section 101 is technical. Section 102 supplies him at the expense of the county with certified copies of the field notes and plats of the original surveys by the United States.

Section 103 tells him how he must survey; other surveyors can do as they think best.

Section 104 is technical. Section 105 gives him the preference in a neighborhood quarrel.

Section 106 prescribes his fees which are not exorbitant.

In the following cases the officials having charge of the work are left free to employ any surveyor they may choose: Highway commissioners, section 8 of chapter 10; commissioners of partition, section 26 of chapter 196; commissioners on lighthouse sites, section 2 of chapter 222, compiled laws of 1871; commissioners on State roads, act 154, laws of 1869, on page 449, compiled laws; boards of supervisors in marking section corners, acts 159 of 1876, and 205 of 1879; the commissioner of the State land office in restoring lost corners and marking unsurveyed ones, act 11; laws of 1879. Perhaps some of you may think I was mistaken in calling Michigan doubtful. I may have been.

Of surveyor's conventions I have noted the following: The two held in this State in 1868 and 1869, under the old organization, the first of which did not discuss the office of county surveyor, or the subject of examination and license; but the second, the one held at Grand Rapids, took a decided stand against our present system of county surveyors and in favor of a State board of examiners, who should grant licenses or diplomas to competent surveyors. Mr. Tinkham saying that some eminent lawyers had given the opinion that no such office as county surveyor had ever been legally established.

The next convention bearing on the subject, of which I have any notes, was held January 7, 1879, by the civil engineer's club of the northwest, at which Mr. James M. Bourne of Springfield, Ill., read the draft of a law for the examination and appointment of licensed surveyors. As most of you have doubtless received a copy of the same from Mr. Bourne, I will not notice it farther than to say that it was followed by a thorough discussion, in which county surveyors were handled without gloves.

The next association in order was that of the county surveyors of Ohio, January 15, 16 and 17, 1880. They did not call for the abolition of the office, but would restrict it to those who have passed an examination and possess the qualifications necessary to civil engineering. They were in favor of a State board of examiners, calling for better and more accurate instruments, surveyors educated to a higher standard, and fuller and more complete plats, maps and records.

I need but mention our first annual meeting held March 24, 25 and 26, 1880.

On October 20, 1880, the surveyors of Kansas held a convention at Junction City, but after repeated efforts I have been unable to open any communication with Mr. Hibben of Emporia, Lyon Co., the secretary, and do not know the range of their discussion.

On October 27, 1880, the engineers and surveyors of Pennsylvania met in convention at Harrisburg. Although they did not discuss county surveyors, it was conceded that they had better ones under the old system of appointment by the surveyor general than they could get by election. They called for better instruments, to be kept up to a high standard by periodic tests, especially chains and needles, also for a stricter enforcement of the law establishing the true meridian and a standard United States measure in each county. The draft of a law for a State board of examiners covering also the above points, was submitted, freely discussed and amended, after which a committee was appointed to submit it to the legislature.

On October 6, 1880, a congress of surveyors general convened at Salt Lake City, Utah. The main point of interest to us in that congress is contained in the closing words of commissioner Williamson: "It will tend to a more uniform system of administering their duties, and lead to improvements in methods."

The cry is heard, from the lowest to the highest, all along the line, "Surveyors, advance."

From this study I have come to this conclusion: Give us as little law as possible on surveying, but a simple, comprehensive, yet strict law, looking toward better and more accurate instruments, surveyors of larger and better training, fuller and more complete records.

ABOUT CORNERS.

BY FRANCIS HODGMAN, COUNTY SURVEYOR, KALAMAZOO, MICH.

The corners I refer to are not corners in pork or grain, but those points which are located by original land surveys to determine the length and direction of boundary lines. I do not expect to advance anything not already well known to surveyors of experience, but the paper and its discussion may bring out points of value to each of us. What I have to say has more especial reference to a condition of things such as I find in Kalamazoo and adjoining counties, and will have but little bearing in a region where the corners of the original surveys are marked by suitable, permanent monuments.

In the region mentioned, I find that the United States government many years since caused the boundary lines of townships and sections to be run out, which lines, the law declares, "shall be established as the proper boundary lines of the sections or subdivisions for which they were intended."

At the intersecting points of these boundary lines are the corners, which are designated by certain marks. The same law of congress declares that these corners "shall be established as the proper corners of the sections or subdivisions of sections which they were intended to designate." All the land has been sold subject to the provisions of this law, and all titles run directly or indirectly to those boundary lines and corners established by the United States survey. See *Billingsby vs. Bates*, 30 Ala., 378; *Arnier vs. Wallace*, 28 Miss., 556; *Johnson vs. Gresham*, 5 Dana (Ky.), 543, 23d Wis., 530. The same principles which apply to the corners and lines of the United States survey, I understand also to apply to the corners and lines of all original surveys, such as for village plats, etc., after the land has been sold by them. The fundamental points and lines having been thus legally determined when the first stakes were set, the surveyor who is now called on in the practice of his profession has a two-fold duty to perform *First*, He must take, sift and weigh the evidence which tends to show where those original corners were located, and must determine at what precise point the preponderance of evidence indicates them to be. An argument based on false premises is likely to come to a false conclusion. A survey based on a wrong starting-point is certain to come to a false ending if it be otherwise accurately performed. Hence the necessity for a correct beginning.

In making original surveys comparatively little importance attaches to the starting point so long as it can be easily identified. The surveyor's work is then almost purely mechanical, running lines in certain directions, and making marks at certain distances. But when the lines and corners have been once established, the surveyor's function changes. He has to determine the location of these original corners before he can

even begin the mechanical part of his labors. This is essentially a judicial proceeding which is often very difficult, and requires a tact and skill, in procuring and interpreting evidence bearing on the point, only acquired by long experience and practical work in the field. Thus it may, and often does happen, that one surveyor will fail utterly in finding the marks of an original corner, while another, more apt in discovering the evidences, will strike upon it readily. These evidences are of various kinds, some of which it is the principal aim of this paper to discuss.

I take it that the best possible evidence of the location of an original corner is the monument fixed at the corner when the survey was made. *Vide McClintock v. Rogers*, 11 Ill., 279; also *Gratz v. Hoover*, 16 Penn., State Rep., 232; 16 Ga., 141. After this come witness trees, fences, distant corners of the same survey, and the testimony of persons.

All these latter kind of evidence only go to corroborate the first—and may take the place of the first only so far as they may any of them seem to have weight in any particular case.

The corners of the United States survey, so far as I have observed, were marked by planting a post or stake in the ground. These stakes had notches cut in them, were squared at the top, and set in certain regular positions in the ground. These marks tended to distinguish them from other stakes that might chance to be driven in the ground for any purpose. When trees stood conveniently near, two of them were marked and their directions and distances from the corner were given in the field notes. When no trees were near, a mound was sometimes raised about the post.

It has so happened, in the fifty odd years that have passed since Kalamazoo County was surveyed, that all of those posts have so far decayed that I do not remember to have seen a single one of them standing above the surface of the earth. Some of them have been entirely destroyed, but the bottoms of a great many of them still remain, much decayed, but plainly visible when the surface earth is removed from about them.

To find them, careful manipulation is required. The surveyor first determines as nearly as he can, from extrinsic evidence, the point where the corner post should be looked for. He then with a shovel, spade or hoe, carefully removes the surface earth, a little at a time, being particular not to strike deep at first into the earth at the level as it was when the stake was set. The best, and sometimes the sole evidence of a corner has often been destroyed by an ignorant person striking deep into the ground, expecting to find a sound stake, and casting away the decayed wood and filling up the hole of a rotten one without observing it. If the surveyor is looking in the right place, and the earth has not been previously removed, he will soon come upon the object of his search; but he must be careful lest he mistake it. If the soil is a stiff clay, packed hard as in a road or covered with a sward, he will presently find a hole of the size and shape of the stake which made it. This hole will contain the decayed wood of the stake, and a marking pin may be readily thrust to the bottom. By carefully scraping or cutting away the earth from the top, or cutting down at one side of the hole, its size, shape and direction may be readily discovered. Thus it often happens that the position of a corner is as well and satisfactorily marked by the decayed stake as it was by the sound one. It sometimes happens that new stakes have been driven beside the original stake, so that several different ones will be found by the surveyor. He will seldom have any difficulty in deciding which is the true corner by its appearance, for the first stake will be more completely decayed and of a darker color.

As a rule it will be driven deeper and straighter down than the new stakes. Then, too, the original stakes were generally round, being cut from whole timber, while the later ones were often cut from rails or other split timber, the sharp corners of which can be readily seen in the holes made by them.

There is thus in the appearance of the stakes of the United States survey such peculiarities and such likeness to each other, even when far gone in decay, that the experienced surveyor will be impressed with the appearance of truthfulness pervading them, and will seldom be deceived. This appearance of truthfulness about a stake, which to the surveyor is one of the most valuable parts of the testimony of these silent witnesses, is something that courts and juries can seldom take cognizance of, because, *first*, they speak in a language that courts and juries do not understand, and *secondly*, the evidence is itself destroyed by the surveyor in the taking, and does not come before court or jury in all its freshness, truth and purity. These decayed stakes may be best observed in the light colored subsoil after the black surface mold has been removed. In sandy soil the cavity made by the stake is gradually filled by the falling sand as the wood decays, but the rotten wood discolors the sand so that where it has not been disturbed the position, size and shape of the stake may be readily traced. In the black muck of our marshes and river bottoms it is more difficult to distinguish the stake near the surface, but as the ground is soft and wet the stakes were driven deep, and we may sometimes find in the wet, peaty subsoil the bottom of the stakes so perfectly preserved that even the scratches made in the wood by nicks in the ax are plainly to be seen. When the stakes are constantly wet they do not decay.

Next we consider the bearing or witness trees. These are marked, and their directions and distances noted in order to assist in finding the corner posts set on the survey. These bearing trees are marked with a blaze and a notch near the ground on the side facing the corner. The measures were taken from this notch. At this time most of the living witness trees have grown to such an extent that only a scar remains in sight, to indicate the point where the notch was cut. In order to get at the notch the superincumbent wood, which is in some cases a foot in thickness, will have to be cut away. It will not often be necessary to do this, as we can come sufficiently near the correct point to find the stake without it. But if the stake has been destroyed, or there are several stakes near, we shall need to be exact and measure from the notch. If the tree has been cut down and a sound stump remains the marks will be easily exposed. Sometimes the mark is gone, but a part of the stump is left. At others the stump is gone, but a dish like cavity remains in the earth to show where the tree once stood. We can almost always find under and around these cavities, places where the large roots have penetrated the subsoil, and thus be able to locate within a foot or so the position of the bole of the tree when standing. In looking for a corner post we may frequently assume for the time being, that a certain stump or a cavity where the tree had stood was the stump of, or the place occupied by a bearing tree. If we then measure the required direction and distance, and find a stake, we may reasonably conclude that our assumption was correct. Such assumptions are frequently of great assistance in finding corners. There may be, and I know there are cases, where the original corner stakes have been destroyed, and can be more nearly restored to their original position by measurements from old stump bottoms or holes in the ground than any other way. But bearing trees, however good their condition, are by no means infallible witnesses as to the location of a corner. Mistakes in laying down their direction or dis-

tance, or both, are not rare. (See *McClintock v. Rogers*, 11 Ills., 279.) A direction may be given as north instead of south, east instead of west, or *vice versa*. The limb may have been wrongly read 64° for 56°. The figures denoting the bearing may have been transposed in setting down, as 53 for 35. So, too, the chain may have been wrongly read, as 48 for 52, the links having been counted from the wrong end. Or they may have counted from the wrong tag, as 48 for 38. Mistakes of the nature of these mentioned are common, so that in working from a bearing tree to find a corner, and not finding the stake at the place indicated in the notes, it will be well to test all these sources of error before giving up the search, for as I have said before, the *post planted at the time of the original survey is the best evidence* of the corner it was intended to indicate.

I next consider fences in their relation to corners. *Potts v. Everhart*, 26 Penn., St. Rep., 493. Taken as a whole very little reliance is to be placed on them, although whether any particular fence may be depended on to indicate the true line will depend on the particular circumstances attending that case. In a general and rough way a fence will indicate to the surveyor where to begin looking for his corner. But the practice has been, and still is common, for the first settlers on a section to clear and fence beyond the line in order to have a clear place on which to set their permanent fence when they get ready to build it. Afterward they forget where the line is and set the new fence where the old one stood. Many fences, too, were set without any survey or any accurate knowledge of where the line was, and left there to await a convenient time to have the line established. So, too, where the land has been long settled and occupied, it is a common custom for adjoining land owners by consent to set the fence on one side of the true line, there to remain until they were ready to rebuild, the one party to have the use of the land for that time in consideration of clearing out and subduing the old fence row. The original parties frequently sell out or die, and the new owners have no knowledge of the agreement and suppose the fence to be on the true line. For these reasons fences should be looked on with suspicion, unless corroborated by other evidence, and the surveyor should enquire pretty closely into the history of a fence before placing any great reliance on it to determine the position of a corner. It may be the best of evidence, and it may be utterly worthless.

It not unfrequently happens that there are no trustworthy marks near a corner to direct the surveyor in his search for the post or from which to replace it if it be destroyed. In these cases he must visit the nearest corners he can find in each direction (varying with the circumstances whether it be section corner or quarter post he wishes to find or restore), go through the process of identification with each of them, and then make his point so that it will bear the same relation to these corners as did the original corner post. Many very intelligent gentlemen suppose that if the surveyor can but find one of the corners of the original U. S. survey he can readily determine the position of all the rest from it. They were never more mistaken in their lives. The continual change in the direction of the magnetic needle, the uncertainty as to what its direction was when any particular line was run, the difference in the length of chains, and the difference in the men who use them, introduce so many elements of uncertainty into the operation as to render it one of little value, and not to be resorted to except in the absence of trustworthy evidence nearer at hand.

If it be a section corner you desire to find or replace, and have adjacent quarter posts in each direction to work from, you will not be likely on the one hand to fall more than a rod or two out of the way,

and on the other hand will not be likely to come within a foot or two of the right place. This method will assist you in searching for the original stake, and, if that be destroyed, and no better evidence presents itself, may be used to determine the point where the corner stake shall be placed. The chief difficulty in applying this method to determine corners arises from the fact that the measurements made on the original surveys were not uniform in length on different sections, and frequently not on different parts of the same section. I have measured sections 22 and 23 on a level prairie, along the line of highways, where no obstacles of any kind interfered to prevent accurate work. I took the greatest possible care in the chaining to have it as accurate as chain work can be done. On the north line of section 22 my chaining tallied exactly with that of the United States survey, viz: 79.60. On the north line of section 23 my measure was 80.96; that of the U. S. survey 80.40—a difference of 56 links. Fortunately, all the corners of the original survey on this two miles of line were well preserved, and the distance between quarter post and section corners was uniform on the same section in both sections. But suppose that a part of them had been lost, and it was required to restore the middle section corner (n. e. of 22) from the remaining ones. Omit all consideration of corners north or south, and there remain four different solutions of the problem, depending on which corners were lost and which preserved. Of these different solutions, one would place the corner $9\frac{1}{5}$ links, one 14 links, one $18\frac{2}{3}$ links, and one 28 links, all east of the true corner. This is not by any means an extreme instance, as I have observed discrepancies twice as great. It is given simply to show how unreliable is the evidence drawn from distant corners of the U. S. survey.

Lastly, I shall consider the evidence of living persons: *Weaver v. Robinett*, 17 Mo., 459; *Chapman v. Twitchell*, 37 Maine, 59; *Dagget v. Wiley*, 6 Florida, 482: *Lewen v. Smith*, 7 Port. (Ala.), 428; *McCoy v. Galloway*, 3 Han. (Ohio), 283; and *Stover v. Freeman*, 6 Mass., 441. Conceding all men to be equally honest in their evidence, there is a vast deal of difference among them with regard to their habits of observation and their ability to determine localities. Some have an exceedingly acute sense of locality, if we may so call it, and can determine very accurately the position of any object which they have been accustomed to see; while others seem to have little or no capacity of that sort. In twelve years' almost constant practice in making this class of investigations, I have found many men who would describe accurately the sort of monument used to perpetuate a corner, and who would tell you that they could put their foot on the very spot to look for it; but when the trial came I have found but few of them who could locate the point within several feet, unlesss they had some object near at hand to assist the memory, and even then they would frequently fail.

It may happen where a corner post has been destroyed that its location can be more nearly determined by the testimony of persons who were familiar with it when standing, and can testify to its relations to other objects in its vicinity, than in any other way. But the surveyor in receiving this testimony should ascertain, as far as possible, what are the habits of accurate observation, and the memory of localities possessed by the person testifying, in order to know how much weight to give his testimony.

I have thus far discussed the various kinds of evidence tending to show where original corners were located, upon the theory that, under the conditions as they exist in this State, it is proper matter for surveyors to consider, and that it is an *indispensable preliminary* in most surveys they are called on to make. Unless they determine correctly

these starting points, the mechanical work based on them is valueless and worse than valueless.

I am aware that the supreme court of this and other states have decided that the location of corners is a question of fact for courts and juries, and not for surveyors to determine. (*Stewart v. Carleton*). By that I suppose they mean to assert the right of the courts to review or alter the decision of the surveyor until such a time as an acquiescence by the interested parties in his decision shall have taken the case beyond the power of courts or juries to alter. I do *not* suppose that they intend to imply by that decision that no corner or line can be considered as finally determined as a matter of fact on the ground, until it has been passed upon by courts and juries.

If that *is* what is intended and the people acquiesce in the decision, there will be a fine crop of lawsuits to be harvested before the people will know where their boundary lines are. But I do not suppose the decisions mean any such thing. Probably not more than one corner or line out of a thousand in this State has come before the courts for adjudication. The supreme court has had less than a score of cases brought to its notice by reason of the freaks of opinionated surveyors. The nine hundred and ninety-nine cases out of every thousand have been, and probably will continue to be, decided by the people themselves on the authority of the surveyors and not permitted to come within cannon shot of court or jury, while they can avoid it. But even in the cases which are litigated, so far as the question of the location of old corners is concerned, the courts must take the results of the surveyor's investigations as their guide in making up the decision, or else decide a majority of the cases with all the best and most reliable evidence thrown out, for the reason that they cannot get that evidence without the surveyor's intervention.

This being the case, it is of vital importance that surveyors should be competent as well as honest. To render a surveyor competent to act he should be not only well versed in the mathematical theory of surveying, but be a man of practical experience in the field work. He should be familiar with the laws and decisions relative to corners and boundary lines and the construction of deeds, and should be empowered to administer the necessary oaths and take the sworn testimony of persons offered as witnesses.

The fact that he is such a man should be certified to either by his election as county surveyor or by commission from some properly constituted authority. When corners have been determined on the ground, there should be a complete record kept of them at some accessible public place, but, more important than anything else, they should be so marked on the ground by everlasting monuments that anybody can find them without mistake and beyond question of their identity.

SOCIETY'S FUND ACCOUNT.

From the organization of the Society up to and including Jan. 14, 1881, the amount received is:

For membership fees, and dues for 1881		$174 00
Interest on bank account Jan. 1, 1881		1 98
		$175 98

Payments for same period:

For printing	$27 25	
For postage	9 30	
For discount on Canada currency	10	
		36 65
Cash on hand Jan. 14, 1881		$139 33

Of this balance, $100 is appropriated to expense of committee on manual. The remainder will be applied to issuing this report, and to expense of October meeting of executive committee.

Respectfully submitted,

J. E. SHERMAN,

Secretary and Treasurer.

LANSING, Jan. 14, 1881.

THIRD MEETING

OF

THE MICHIGAN ASSOCIATION

OF

SURVEYORS AND CIVIL ENGINEERS.

HELD AT LANSING, JANUARY 10-12, 1882.

FOURTH MEETING WILL BE HELD AT LANSING, JAN. 9, 1883.

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C. K. WEAD,	PHYSICS.
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J. B. DAVIS,	SURVEYING.
C. N. JONES,	MATHEMATICS AND MECHANICS.
C. S. DENISON,	DESCRIPTIVE GEOMETRY AND DRAWING.

For fuller information or for copies of the last University Calendar, apply to

H. D. BENNETT, Ann Arbor, Mich.

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THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

Organized at Lansing, March 25, 1880.

OFFICERS, 1882.

PRESIDENT, PROF. CHAS. E. GREENE, of Ann Arbor.

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First District—JAS. SANDERSON, - - P. O. Detroit.
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Second—JOHN K. YOCUM of Washtenaw, " Waterloo.
Third—C. M. C. SNOVER of Jackson, - " Jackson.
Fourth—FRANCIS HODGMAN of Kalamazoo, " Climax.
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Ninth—GEO. E. STEELE of Grand Traverse, " Elk Rapids.

SECRETARY AND TREASURER, R. C. CARPENTER of Lansing.

EXECUTIVE COMMITTEE.

BURTON KENT of Adrian, M. W. BULLOCK of Howell,
WM. DONOVAN of Lansing, and the PRESIDENT
and SECRETARY, ex officio.

SPECIAL COMMITTEE ON MANUAL.

THOMAS LOVE of Avery, GEO. E. STEELE of Elk Rapids,
and FRANCIS HODGMAN of Climax.

SPECIAL COMMITTEE ON LEGISLATION.

GEO. E. STEELE of Traverse City, BURTON KENT of Adrian,
PROF. J. B. DAVIS of Ann Arbor, A. J. TEED
of Cadillac and the PRESIDENT.

ROLL OF MEMBERS WITH P. O. ADDRESS.

Arnold, A. R., Mt. Pleasant.
Bullock, M. W., Howell.
Bailey, M. H., Dimondale.
Beden, S. N., Pine Run.
Bannister, A. M., Jackson.
Bartholomew, H. D., Lansing.
Hodgman, F., Climax.
Hyde, Chas. B., Jackson.
Heald, P. C., Midland.
Huggins, Andrew, Corunna.
Hamilton, Chas., Bronson.
Holmes, Chas., East Saginaw.

ERRATA.

LIST OF MEMBERS.

Page 3.—J. R. Dixon, Charlevoix, instead of Boyne Falls.
G. E. Steele, Grand Traverse, instead of Elk Rapids.

Cook, M. S., Manistee.
Davis, Prof. J. B., Ann Arbor.
Drew, A. L., Three Oaks.
Donovan, Wm., Lansing.
Dixon, J. R., Boyne Falls.
Drake, A. P., Mason.
Dunbar, E. L., Bay City.
Eaton, Albert, Otsego.
Fosdick, A. A., Gaylord.
Foster, R. J., Coopersville.
Fessenden, C., Romeo.
Guild, E. F., East Saginaw.
Gulley, D. E., Tawas City.
Gardner, Albro, Allegan.
Greene, Prof. C. E., Ann Arbor.
Gillette, L. S., Niles.
Greiner, R. C., Grand Rapids.
Goodell, E. J., Ecorse.
Glaser, Chas. A., West Bay City.
Hollister, C. E., Laingsburg.
Mitchell, Jno. A., Ludington.
Mark, Geo. A., Hillsdale.
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Niles, I. P., Coopersville.
Olmstead, H. F., Midland.
Palmer, Jno. O., St. Johns.
Pearsons, H. C., Ferrysburg.
Pierce, A. J., South Haven.
Palmer, A. H., River Raisin.
Palmer, F. A., McBride's.
Pettibone, D. A., Bridgeport.
Reed, A. L., Port Huron.
Rothwell, H. G., East Saginaw.
Skeels, D., Grand Rapids.
Stage, M. B., Clio.
Smith, E. C., Pontiac.
Snover, C. M. C., Jackson.
Steele, Geo. E., Elk Rapids.
Sinclair, A., Port Huron.
Smith, Amos, Vandalia.

* Deceased.

THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

Organized at Lansing, March 25, 1880.

[redacted]

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Bailey, M. H., Dimondale.
Beden, S. N., Pine Run.
Bannister, A. M., Jackson.
Bartholomew, H. D., Lansing.
Blair, James, Adrian.
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Brown, Geo. M., East Saginaw.
Bates, A. W., Gaylord.
Bonnell, B. C., Pioneer.
Brown, Thomas J., Mason.
Bradt, J. C., Marcellus.
Baker, Chas. L., Ann Arbor.
Begle, Chas. A., East Saginaw.
Carpenter, Prof. R. C., Lansing.
Cook, Percy T., Grand Rapids.
Cooley, Sloan, Four Towns.
Caukin, H. M., Greenville.
Cummings, Geo. P., Marquette.
Cobb, L. S., Winfield.
Cary, Harrison, Saginaw City.
Cornell, Thomas, Ionia.
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Cook, M. S., Manistee.
Davis, Prof. J. B., Ann Arbor.
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Love, Thomas, Avery.
Lawton, C. D., Lawton.
Lovewell, N., Coldwater.
LaRue, B. F., Freedom.
Lawson, J. S., Disco.
*Mason, Lyman, Owosso.
Masson, Geo., Detroit.
Martin, E. C., Evart.
Mitchell, Jno. A., Ludington.
Mark, Geo. A., Hillsdale.
McElroy, Michael, East Tawas.
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Sinclair, A., Port Huron.
Smith, Amos, Vandalia.

* Deceased.

Sanborn, J. M., Pine Run.
Smith, J. N., Bath.
Strudwick, Henry, Bad Axe.
Sherman, J. E., Lansing.
Smith, Richard, Port Austin.
Sanderson, Jas., Detroit.
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Todd, O. H., Colon.
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White, Thomas, Alpena.
Watkins, John J., Lapeer.
Walker, I. O., Ann Arbor.
Whallon, J. M., Fitchburg.
Wellas, B. F., Marshall.
Woodward, C. S., Ypsilanti.
Wilmarth, A. H., Sand Hill.
Yocum, J. K., Waterloo.

HONORARY MEMBERS.

John F. Munro, Detroit.
W. L. Coffinberry, Grand Rapids.

Pierson, Geo. S., of Kalamazoo, application received too late to be acted on by the society at the last meeting.

THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

THE CONSTITUTION.

PREAMBLE.

For the purpose of improving ourselves in the knowledge of our profession, and securing greater uniformity in our methods of practice, we, the undersigned civil engineers and surveyors, hereby associate ourselves together under the name of the Michigan Association of Surveyors and Civil Engineers, and adopt the following as our constitution and by laws:

SEC. 1.—OF MEMBERSHIP.

Any surveyor or civil engineer in good standing in the profession may become a member of this society by signing the constitution and paying two dollars into the treasury: *Provided*, That all applications for membership shall be endorsed by at least one member of the society, and by the executive committee; and further, that each applicant shall receive a three-fourths majority vote of the members present at any regular meeting, not less than a quorum being present.

SEC. 2.—OF OFFICERS.

The officers of this society shall be a president, a vice-president in each congressional district in this State, and a secretary, who shall also be the treasurer.

The treasurer shall give bonds in such sums as the society shall from time to time determine, and shall make a report of the finances of the society at each annual meeting.

SEC. 3.—DUTIES OF OFFICERS.

The duties of these officers shall be such as are performed by similar officers in other societies. They shall hold their offices for one year, and until their successors are elected and qualified.

SEC. 4.—OF ELECTIONS.

Elections of officers shall be by ballot, and shall be held on the last day of the regular meeting in January of each year.

SEC. 5.—OF AMENDMENTS.

This constitution may be amended at any regular meeting by a majority of two-thirds of the members present: *Provided*, That such amendment shall have been submitted in writing on the first day of said meeting and referred to a committee for consideration

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BY-LAWS.

SEC. 1. A quorum for the transaction of business shall consist of ten members.

SEC. 2. There shall be a regular meeting in each year, commencing on the second Tuesday of January at two o'clock P. M.

SEC. 3. Special meetings may be held at any time on call of the executive committee.

SEC. 4. There shall be an annual due of one dollar, payable on the first day of the regular meeting; and no member of the society shall be entitled to vote, or to any of the rights, benefits, or privileges of the society while in arrears for dues.

SEC. 5. There shall be an executive committee of five members, of which the president and secretary shall be members *ex officio*, who shall have general charge of the business transactions of the society. This committee shall be appointed by the president, and its members will hold their office for one year and until their successors are appointed.

Special committees will be appointed at any time when their services are demanded.

STANDING RESOLUTIONS.

MANUAL.

Resolved, That a committee of three be appointed to confer with the commissioner of the State land office in regard to compiling decisions of the courts and adopting methods of establishing lines and corners in this State; also to bring the matter before the next legislature.

Resolved, That members of the society and others interested be and are hereby requested to furnish the chairman of the committee on manual with field notes, as taken in the field, of one or more sections they have subdivided; also diagram and full description of (the same) lines and corners as they appear of record, selecting such sections as will in their judgment assist the committee in their work. The object being to secure the committee a large number of representative cases.

Question of riparian rights was, by resolution, referred to the committee on manual.

The foregoing is the original. At the meeting in 1881 the following was added:

Resolved, That the committee on manual be enlarged to four members; that they proceed with the work as rapidly as possible, and that one hundred dollars be appropriated to defray their necessary expenses.

LOST CORNERS.

Resolved, That it is the sense of this convention that a lost corner in the terms of the instructions issuing from the U. S. Land Office for restoring such means a corner about the position of which there is no evidence nearer than the nearest monument of the original land survey; also that the instructions should not be applied to these cases until other sources of evidence are exhausted.

LANDMARKS—(ADOPTED IN 1881).

Preamble. In view of the rapid destruction of landmarks which is being carried on by destroying witness-trees and obliterating the evidences of the United States survey, and in view of the expense and difficulty of restoring these corners when lost, the ill-feeling and litigation which follows their loss:

Resolved, That we recommend to the people of the State and to boards of supervisors that immediate steps be taken to preserve all the corners of the United States survey; and

Resolved, That in perpetuating these corners the best and most durable materials should be used for landmarks, and that they should be properly lettered and numbered for the corners they designate; and

Resolved, That as a matter of public economy we recommend that such work should be done, not by the person who will do it for the least money, but by the persons who will be likely to do it the most thoroughly; and that all obtainable evidence in regard to the locations of these corners should be got together and thoroughly sifted by the surveyor before any such landmarks are placed.

THE EXECUTIVE COMMITTEE.

Resolved, That the executive committee be directed to meet at least 60 days prior to each annual meeting of this society.

Said committee shall divide its work and designate one of its members to have charge of each subdivision so made, and of all correspondence relating thereto.

That members of this society, or of the profession, having questions of practice or topics which they wish discussed by the society, shall submit the same to the committee as early as possible during the year. All matters to come before the society the committee shall, so far as possible, prepare and present in convenient form for its action.

That said committee prepare and distribute a programme of the business so arranged.

That the necessary expenses of the committee for such meeting shall be paid by the treasurer of the society.

The committee will meet about Oct. 15, 1882. Any "practical questions" or other matter on which decisions are needed may be referred at any time to the President or Secretary.

THIRD ANNUAL MEETING

OF THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS, HELD AT LANSING, JANUARY 10-12, 1882.

SECRETARY'S REPORT OF THE PROCEEDINGS.

SALUTATORY.

Our Secretary for 1881, J. E. Sherman, being obliged to leave Lansing on account of business connections, his work fell into new hands. Wm. Donovan, C. E., of Lansing, accepted the position until the time of the regular meeting, but on account of pressure of business did not feel willing to serve for 1882. The present secretary expresses, what is the known opinion of every member of the society, "that to the activity and energy of J. E. Sherman in its behalf the society owes, in a great part, its present prosperity. Although some remuneration was voted him, he has never drawn it from the treasury, and consequently has never received any compensation for his work for the society. Whatever business he may follow, wherever he may be located, we shall always feel that his interests are ours, and pray that 'success be ever with him.'"

The present winter has been one of the most favorable for active surveying and engineering work ever experienced in this State. The result has been that at our time for meeting at Lansing nearly every surveyor or engineer had a pressing business engagement from which it was hard to break away. Despite all that, there was a good attendance, varying from 30 to 70 at each session. Our honored member from Marquette, Mr. G. P. Cummings, was in attendance for the first time. The cordial greetings between the different members as they came together before the opening was in striking contrast to the first session in 1880,—which was remarkable as a meeting of total strangers. This association is the only bond of union between individual surveyors and engineers of our State; it affords to them a means of mutual acquaintance, of education,

and finally constitutes an organized body which can be made to exert a great influence in securing desired legislation. The aim is to compactly unite all civil engineers and surveyors, whatever special branch they may follow, and to secure that end matters of interest to each particular profession will receive attention at the regular meetings.

The proceedings, will, as usual, be presented by subjects instead of order of occurrence.

AMENDMENTS TO CONSTITUTION.

By a majority vote the amendments to the Constitution proposed at the second annual meeting were adopted. The amendments are incorporated in the Constitution as published. They were as follows:

SEC. 1. To strike out from line 5 the words "shall be placed in the hands of," and from line 6 the words "at least three months before the annual meeting."

SEC. 2. By adding after the word "determine" in the last line the words "and shall make a report of the finances of the society at each annual meeting."

SEC. 5. By striking out all after the word "Provided," and substituting therefor the words "such amendments shall have been submitted in writing on the first day of said meeting and referred to a committee for consideration."

MEMBERSHIP.

By vote of the Society the following new members were admitted: Arthur W. Bates, D. E. Guiley, B. F. LaRue, I.O. Walker.

MANUAL.

The Committee reported that on account of pressure of private business upon the different members it had not been possible to devote much time to this work. The work of compilation had been divided as follows among the different members of the Committee: History, to G. E. Steele; Instructions to Surveyors, to T. Love; Court Decisions, to F. Hodgeman and R. C. Carpenter. Very much of the material needed has been compiled but not arranged. On account of the great pressure of surveying business, the outlook for a speedy completion of the work is not favorable. The committee was continued for another year.

There is a pressing demand for the work, as exhibited by numerous letters of inquiry not only from Michigan surveyors but from surveyors from all portions of the United States.

LIBRARY COMMITTTEE.

Professors Green, Davis, and Carpenter were appointed on a committee to suggest a list of books to the State librarian that would be useful to the members of the association if owned by the State Library.

The following books on engineering or surveying subjects are now to be found in the State library and are open for consultation to any person visiting the library:

Alexander—Report on Irrigation in California	1874
Arnott—Elements of Physics	1831
Babbage—Economy of Machinery	1832
Beckmann—History of Inventions	1846
Cavallo—Elements of Natural Philosophy	1803
Comstock—Report on Survey of Northern Lakes	1875
Report on European Surveys	1876
Farrar—Treatise on Optics	1826
Fairchild—Improvement of Navigation on Wisconsin and Fox Rivers	1869
Franklin Institute Journal (nearly complete)	
Gannett—List of Elevations in Western United States	1875
Gardner—The Elevation of Certain Datum Points on the Great Lakes and Rivers	1875
Gillmore—Strength of Building Stones	1874
Goodrich—Progress of Science and Mechanism	1854
Guyot—Earth and Man	1853
Gouge—New System of Ventilation	1870
Keurty—Effect of Sea Water on Iron Piles	1874
Knight—Mechanical Dictionary	1877
Lardner's Mechanics	1835
Leeds—Ventilation	1871
Report of Engineers on the Basin of Mississippi	1875
Technology (Illustrated)—Treatise on Woods, etc	1856
Weitzel—St. Mary's Falls Canal	1874
Wheeler—Surveys West of 100 Meridian	1874
Young—Elements of Mechanics	1834
Geological Surveys of Various States and Territories	
Appleton's Dictionary of Machines, etc	1852
Barlow—Strength of Materials	1857
Herbert—Engineer and Mechanics' Encyclopedia	1838
Tredgold—Principles of Carpentry	1837
Ures—Dictionary of Art, etc	1863
Patent Office—Complete Reports	
Abert—Chesapeake and Ohio Canal	1838
American Society Civil Engineers	1874
Bree's Railway Practice	1837
Brown—First Locomotives in America	1871
Bruff—Engineering Field Work	1838
Fairbain—Political Economy of Railroads	1836
Haupt—Bridge Construction	1867
Herbert—Railroads and Locomotives	1837
Mahan—Civil Engineering	1867
McAdam—Road Making	1823
Mifflin—Railway Curves	1837
Parnell—Treatise on Roads	1838
Simm's Practice of Leveling	1837

Simm's Surveying Instruments..... 1836
Stevenson—Civil Engineering in North America..... 1838
Tables and Formulæ used in Surveying, etc..... 1873
Tredgold—Railroads and Carriages..... 1835
Turnbull—Piers of Aqueduct of Alexandria Canal..... 1873
Van Nostrand's Engineering Magazine (complete).....
Wilkes—Hydrography, United States Exploring Expedition.. 1838
Wood—Railroads..... 1832
Woodbury—Stability of Arches..... 1858
Appleton's Cyclopedia of Drawing..... 1864
Land Office Reports of the United States.....
Reports of Various Supreme Courts.....

EXHIBITION OF INSTRUMENTS.

But few instruments were on exhibition at the late meeting. Mr. M. S. Cook, of Manistee, exhibited a mountain transit made by W. & L. E. Gurley; Mr. S. Hodgeman, of Traverse City, exhibited a steel tape of his own manufacture, and which he sells at a reasonable rate (see advertisement). Mr. Bailey also exhibited a steel tape of his own manufacture, one of which he promised to donate to J. Ludington, a sufferer in the recent forest fires. It was determined to make the instrument exhibition a prominent feature for 1883.

The following resolution was adopted, to which it is hoped each member will respond by putting on exhibition his instruments of practice:

Resolved, That in connection with the meeting of 1883 we hold an exhibition of surveyors' and engineers' instruments, and to secure that end all are invited to exhibit their instruments of practice.

LEGISLATION.

Prof. Greene read the bill in the interests of surveyors submitted to the Legislature at its last session. This bill passed the Senate but was killed by the adverse report of the House committee on geological survey. The report of the committee was also read.

The following is the text of the bill submitted:

A BILL to establish a Board of Commissioners of Surveys, to prescribe their duties, and to fix their compensation; and to further provide for the public surveys.

SECTION 1. *The People of the State of Michigan enact*, That a State board of commissioners of surveys is hereby established, to be composed of three members, each of whom shall have been for at least five years before his appointment a practical land surveyor within this State. The members of the board shall be appointed by the Governor with the advice and consent of the Senate. And the members first appointed shall be designated by the Governor, one for the term of office for two years, one for the term of office for four years, and one for the term of office for six years; and thereafter the Governor, with the advice and consent of the Senate,

shall biennially appoint one member to hold his office for six years, ending May fifteenth. Any vacancy in said board may be filled, until the regular session, by the Governor.

SEC. 2. Each member of said board shall take the constitutional oath of office before some officer authorized to administer oaths, and shall enter into bonds with the people of the State of Michigan in the penal sum of three thousand dollars, with sureties to be approved by the Governor, conditioned for the faithful and impartial performance of the duties of his office, and shall file such bond and oath of office in the office of the Secretary of State.

SEC. 3. That member of the board, whose term of office will soonest expire, shall be the chairman thereof. The board, or a majority thereof, shall hold regular meetings at the State land office in Lansing, on the last Wednesday of January in each year.

SEC. 4. The Commissioner of the State land office shall, at the first regular meeting of said board, designate one of the regular clerks of his office to act as secretary thereof. It shall be the duty of such secretary to attend the sittings of the board, to record its proceedings, to preserve its books, papers and property, attend to its correspondence, and perform such other duties as may be required of him by said board.

SEC. 5. The board shall be a board of examiners, and shall make public examinations of persons for land surveyors. Every person arising to practice as a land surveyor within this State shall give notice to the secretary of the board at least two weeks previous to a regular meeting thereof, and at the meeting designated such applicant shall appear in person, and, when required by the board, bring his instruments; and previous to such examination shall satisfy the board that he is a person of probity and sobriety.

SEC. 6. The board shall examine such applicant with regard to his proficiency in mathematics as applied to surveying, the United States public land system, the adjustment of instruments, map-drawing, and the recording of surveys, and with special reference to the actual practice of the applicant in the field, his previous preparation and experience, and may require the applicant to perform such practical operations in their presence as they may deem necessary.

SEC. 7. The board, after being satisfied of the ability of the applicant, as provided in section six of this act, and of the sufficiency and correctness of his instruments, and, after such applicant shall have taken the constitutional oath of office and paid into the treasury of the State of Michigan the sum of five dollars, shall make and deliver to him a certificate in the following form, to wit: This is to certify that....., of ....., in the county of ....., in the State of Michigan, has duly passed his examination before the State board of commissioners of surveys of the State of Michigan, and has been found qualified to perform the duties of land surveyor. Wherefor, the said ..... is hereby authorized to practice as a land surveyor, with authority to take testimony in all matters pertaining to his profession, and administer oaths to his assistants within, and in any part of the State of Michigan until this appointment and authority shall be revoked.

[Signed]

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.....
.....

Board of Commissioners of Surveys.

But said board of commissioners, if they find an applicant is not sufficiently qualified, or, if from his inexperience in the field, he does not seem to have sufficient practical acquaintance with his profession, shall encourage him to prepare himself for further examination.

SEC. 8. The secretary of the board shall, before the delivery of any such certificate, make a record thereof. Any surveyor holding such certificate shall be deemed a registered surveyor within the meaning of this act.

SEC. 9. The board shall revoke the appointment of any registered surveyor whom they may find guilty of gross negligence or corruption in the execution of the duties of his office, but not without having previously summoned him to appear in order to be heard in his defense, nor without having heard the evidence offered either in support of the complaint or in behalf of the surveyor inculpated.

SEC. 10. The board shall send to the county clerk of each county at the close of each regular meeting, a list of the names of all surveyors to whom they have at such meeting granted certificates, and of those whose appointments have been at the same time revoked.

SEC. 11. The board of commissioners of surveys is hereby required to provide itself at the expense of the State with suitable standards of length from the office of the United States inspector of weights and measures.

SEC. 12. Every registered surveyor shall provide himself with a standard of lineal measure, which shall be certified by the secretary of the board or by the United States inspector of weights and measures, as being correct with the United States standard of length, and he shall keep his chains and tapes used, in agreement with such standard.

SEC. 13. The board of commissioners of surveys shall be an advisory board on questions of boundary, extinct or disputed corners, and all difficult questions of surveying practice submitted to them by registered surveyors.

SEC. 14. The said board shall endeavor to secure uniformity in the practice of registered surveyors, and in re-establishing and perpetuating the United States surveys; they shall endeavor to conform to the plan on which these surveys were made, to the end that lost corners and lines may be re-established in their original position.

SEC. 15. Each member of the board of commissioners of surveys shall receive ten cents a mile for each mile necessarily traveled in going to and returning from their place of meeting at the capitol at Lansing, and his necessary expenses during the session of said board. Said mileage and expenses shall be allowed by the board of auditors and paid by the State treasurer on the warrant of the Auditor General. The necessary expenses of said board for stationery and instruments for their office and of their secretary while engaged in the performance of his duties shall be audited and allowed by the board of State auditors and paid by the State Treasurer on the warrant of the Auditor General.

SEC. 16. Each registered surveyor shall keep a full and complete record of surveys made by him, in a book of such form and size as shall be prescribed by the board of commissioners of surveys, and within ten days previous to the first day of January of each year, shall, at his own expense, deposit said record in the office of the county surveyor of the county in which the surveys were made, and each county surveyor receiving such record shall give to the person depositing the same a receipt therefor, but no record shall be received by such county surveyor unless made by a regis-

tered surveyor whose certificate, as shown by the list on file in the county clerk's office, was in full force at the time the survey was made. The expense of making a record of any surveys made by a registered surveyor shall be paid by the persons for whom the survey was made, in proportion to the amount of work done for each.

SEC. 17. The record, or a certified transcript thereof of any survey made by such registered surveyors, shall be received as presumptive evidence of the facts therein set forth in all courts of record in this State.

SEC. 18. Whenever a majority of the resident owners of any section, or part or parts of any section of land in this State shall desire to have their corners and lines, or any of them, established, re-located or perpetuated, they may apply to a registered surveyor to make the required surveys, who shall immediately give the applicant a notice, who is hereby required to serve the same on all other persons owning land in the same section, or to their agents, residing in the same township, informing them that at a day mentioned, not less than ten days from the date of the notice, the required surveys will be made.

SEC. 19. The registered surveyor, when being satisfied that notice has been given, and no injustice will be done the parties not signing the application, shall make the surveys asked for, and the expense thereof shall be borne by all the persons benefited in proportion to the work done for each, to be determined by the surveyor; and if any person thus benefited shall refuse or neglect to pay his share of such expense, such surveyor shall certify the same, and to whom due, to the supervisor of the proper township, who shall assess it upon the land of such person, to be collected in the same manner as other taxes, and held subject to the order of the person named in the surveyor's certificate as being entitled to the same: *Provided*, In such cases the surveyor shall not charge to exceed four dollars a day, including the time of traveling to and from the place of making the survey, and of making record of the same.

SEC. 20. No registered surveyor shall be liable to prosecution in an action of trespass for entering upon any lands in the discharge of his duties.

The foregoing bill passed the Senate without amendment; in the House was referred to the Committee on Geological Survey, who made the following report:

[See pages 848-850 House Journal, 1890-L.]

The Committee on Geological Survey, to whom was referred Senate bill No. 20 (file No. 14), entitled "A bill to establish a board of commissioners of surveys, to prescribe their duties, and to fix their compensation; and to further provide for the public surveys," respectfully report that they have had the same under consideration, and find the following objections to the passage of the bill:

1st. Section 1 creates a board of three additional State officers with various but no useful or important duties. No other State officers can perform their duties or receive the appointments, as the bill provides that they shall be practical surveyors of at least five years' experience. This board is by this bill granted power in Sections 11 and 15 to provide instruments, some of which may be very costly, to be paid for out of the treasury of the State, and there is no provision controlling or limiting this dangerous power

to be found in this bill. And your committee are of the opinion that it is unwise and impolitic for this legislature to create a board of three additional State officers, with no better prospects of returning profits than are afforded by the provisions of this bill.

2d. The bill is unjust to the surveyors of the State. Section three provides that any person wishing to practice as a registered surveyor must first give notice to the board and then come to Lansing and be examined; and as the board meets only in mid-winter the whole upper peninsula would be excluded from the benefits of the bill or be subjected to great cost, as well as all other distant parts of the State. Again, Section 7 prescribes the form of certificate which shall be granted, which is liable to deceive the holder, as it declares that he has authority to take testimony and administer oaths, while nowhere in the bill is there granted even the power to swear a flagman—no, not even to swear at him.

3d. This bill does not provide for making surveys according to the laws of the State. Section 14 provides that the board shall endeavor to secure a uniformity of surveys, but does not provide that they shall be made in accordance with the laws of the State. And so with the records: the statutes provide a form for record of surveys, but this bill provides that a uniform record shall be prescribed by the board of registered surveyors, but fails to provide that it shall comply with the law of the State; and such record shall be filed with the county surveyor at the close of each year, thus making as many separate record books in the surveyor's office as there are surveyors working in his county, and these doubling each year as time goes on. This provision in the bill is very objectionable, causing, as it would, great trouble and confusion in preserving, and especially in finding, the records. Again, Section 16 forbids county surveyors receiving any but the records of registered surveyors. This provision will be held as prohibiting the county surveyor from receiving the records of his own deputies.

4th. Section 17 provides that the record of a registered surveyor shall be evidence in courts of records, yet the bill does not provide that either the survey or record shall be made in accordance with the laws of the State. The statutes provide the manner of making surveys and records by county surveyors, and their record is evidence in all courts; so a court may be compelled by this bill to receive as evidence the record of a registered surveyor fixing a corner at a certain point, and also that of the county surveyor showing that it is four rods from there. Therefore this provision is extremely mischievous and objectionable.

5th. Section 19 grants power to a registered surveyor to do work, and at his own discretion and without appeal to cause to be levied on your farms taxes that must be paid as he has apportioned them; and Section 20 empowers him to enter your premises with impunity; and yet nowhere in this bill is there any provision that he shall give a bond for the just apportionment of your taxes, or that he will not do damage to your property while upon your premises. He has all the above powers and yet you cannot command his services as there is no provision in this bill to compel him to make a survey unless he pleases, as is the case with the county surveyors; not even a court can compel or command his services; he is by this bill above all law.

6th. It is claimed by the surveyors' association who drafted this bill that it will secure greater accuracy and uniformity in making surveys, and in their records. But your committee find that the present statutes direct how surveys shall be made and also for a specific and uniform record of the same. Therefore this bill can be

of no benefit in that direction, and if the board of surveys should prescribe a different method of making surveys or records, it could only produce conflict and confusion, and result in great harm to the service. And your committee would further report that they have thoroughly examined and carefully considered the numerous petitions and many letters for and against the adoption of the bill, and after such careful consideration your committee are of the opinion that the measure would be a needless expense to the State and a damage to the surveying service and to the surveyors themselves. Your committee therefore respectfully report the bill back to the House and recommend that it do not pass, and ask to be discharged from the further consideration of the subject.

J. H. BENNETT.
JAMES MERCER.
SAMUEL M. WILKINS,
A. P. YOUNG,
JAS. EAKINS.

Report accepted and committee discharged. On motion of Mr. Diller, the bill was laid on the table.

The following resolution was adopted by the society:

Resolved, That a committee appointed by the president and of which the president shall be a member, be empowered to reconsider the bill submitted to the Legislature in 1881, and report a new bill for the consideration of the society at its next meeting.

The committee appointed was G. E. Steele, B. Kent, J. B. Davis, A. J. Teed and the president.

RELIEF FUND.

This fund was collected through the efforts of our Secretary for 1881, Mr. J. E. Sherman, to furnish aid to those members of the society and of the profession who suffered in the late forest fires, and especially Mr. Henry Strudwick, of Bad Axe, who lost nearly all he possessed by the fires. The appeal for help was given a wide circulation through the kindness of the editor of the Engineer News, who published it in his columns. The following is the list of contributors to this fund:

A. W. Bates, Gaylord	$1 00
J. C. Bradt, Marcellus	2 00
I. N. Boutell, Clinton, Iowa	5 00
H. D. Bartholomew, Lansing	1 00
G. H. Carleton, Sault Ste. Marie	3 00
R. C. Carpenter, Lansing	5 00
Percy T. Cook, Grand Rapids	2 00
J. R. Dixon, Charlevoix	5 00
G. H. Frost, New York	25 00
C. E. Greene, Ann Arbor	2 00
E. F. Guild, East Saginaw	2 00
B. Kent, Adrian	2 00
T. Love, Avery	2 50
B. F. LaRue, Freedom	5 00
A. Noble, Sault Ste. Marie	2 00
F. S. Odell, New York	5 00
H. C. Pearsons, Ferrysburg	5 00

J. O. Palmer, Spencerport, N. Y.		1 00
J. M. Sanborn, Pine Run		4 00
J. N. Smith, Bath		1 00
E. G. Soltman, New York, cash	$5 00	
Drawing instruments sold for	8 50	
Tracing cloth sold for	4 00	
Paper sold for	1 90	
		19 40
A. Smith, Vandalia		2 00
Wm. Vincent, Manistee		2 00
T. White, Alpena		1 00
Cash from Boston		1 00
Total		$105 90

M. W. Bailey, Dimondale, steel tape sent to J. Ludington.

By order of the executive committee, the acting secretary, Mr. Wm. Donovan, purchased for Mr. Strudwick a compass and chain, as well as furnishing some other material that had been donated.

Later the society heard that J. Ludington, a surveyor residing at Verona Mills, Huron county, had lost his instruments, and other property, by the late fires. Finding this report to be true, after ascertaining his needs, the society ordered the secretary to purchase a compass, the cost not to exceed forty dollars.

Both Messrs. Strudwick and Ludington return to the society their heartfelt thanks, and express themselves well fitted out for work.

The following shows the amount expended:

Jan. 7—Compass for Henry Strudwick		$40 00
7—Chain for Henry Strudwick		3 00
Feb. 18—Compass for J. Ludington		30 00
18—Draft and expressage		1 40
		$74 40
Balance of relief fund in treasurer's hands		$31 50

A vote of thanks was tendered the following persons not members of the association, each of whom contributed to the relief fund five (or more) dollars: G. H. Frost, New York; E. G. Soltman, New York; F. S. Odell, New York; I. N. Boutell, Clinton, Iowa.

In view of the liberal donations of G. H. Frost and E. G. Soltman, one-half page for advertising was placed at their disposal.

By resolution the secretary and treasurer was made the custodian of this fund.

LYMAN MASON.

The following resolutions in regard to the late Lyman Mason were adopted by the society:

Resolved, That by the death of our respected brother, Lyman Mason, the society has been deprived of an efficient member, and the State has lost the services of an accomplished engineer.

Resolved, That we tender our heartfelt sympathy to his bereaved wife and friends.

Resolved, That we publish in the proceedings of the society a concise history of his life.

R. C. CARPENTER,
W. DONOVAN,
A. M. BANNISTER,
Committee.

BIOGRAPHICAL SKETCH OF LYMAN MASON.

Lyman Mason was born in the township of Owosso, Feb. 14, 1847. Upon the death of his mother, and at the age of fourteen months, he was removed to Rochester N. Y., where he remained until his thirteenth year. He pursued his primary studies at the Owosso High School. In the year 1869 he graduated from the Agricultural College at Lansing, and in 1871 from the Scientific Department of the State University with the degree of C. E. The same summer he also received the degree of Master of Science from the Agricultural College. He was married on the 24th of December, 1872, and has since made his home in Owosso. To quote from the Corunna American, "the county of Shiawassee has lost an efficient officer, and Owosso an honored citizen in the death of Civil Engineer L. Mason, which occurred Saturday night, July 16, 1881. He literally 'died on the field' while at work on the extension of the J., L. & S. R. R. in Gaylord, only a few miles from the section of the road he was completing, highly respected and greatly mourned. His remains were brought home on a special train on Monday, in charge of a brother and brother-in-law, and his invalid wife. He was a fine student, an accurate surveyor and engineer, an industrious and successful man, and in every sense a most worthy citizen, falling in the prime of life by fell disease, 'hacked down, his thick, summer leaves all faded.' Mr. Mason was serving his fourth term as County Surveyor of Shiawassee county, and has been City Surveyor of Owosso a number of years."

PAPERS AND COMMUNICATIONS.

The papers read by Prof. Carpenter on Drainage Engineering, by Prof. Greene on Deep Water Foundations, Mr. G. W. Pearsons on Waterworks for Small Cities, Mr. H. C. Pearsons on Defects of the Needle Experienced on Board Vessels, and by Burton Kent on State Reform School for Girls, were received with evident interest, but did not excite much discussion.

The work of preparing the questions of practice for the society was submitted to Mr. T. H. Leavenworth, of Saginaw, by the executive committee. His paper was an admirable one, and served to introduce a discussion which there was not time to finish.

A vote of thanks was tendered to the persons who prepared the papers. They were read in the order given above, but for convenience of the secretary are printed in a different order.

FOUNDATIONS AND PIERS OF THE WHEELING & LAKE ERIE RAILROAD BRIDGE ACROSS THE MAUMEE RIVER AT TOLEDO, OHIO.

BY CHAS. E. GREENE.

The writer has thought that a paper descriptive of the recent construction of the piers of the above bridge will be of interest to the association, because the operations carried out in this instance, modified of course by the necessities of each particular case, are the ones likely to prove most general in application, to require only the simplest appliances, and to be within the reach of any engineer.

As the specifications for this bridge were drawn up, the contract let, and the construction begun before the writer became connected with the work, it will be understood that the dimensions and plan of operations were already fixed and that he simply desires to give here the method as it was carried out and the results attained by others than himself.

DESCRIPTION OF THE BRIDGE.

The bridge now under construction for the Wheeling & Lake Erie R. R. Bridge Company crosses the Maumee river about one and one-half miles below the main portion of the city of Toledo, Ohio, at a place locally known as Manhattan. The superstructure is to consist of nine spans of combination truss of the Whipple type, of 180 feet span each between centers of piers, and an iron draw span of 340 feet, giving two openings of about 150 feet each. The draw covers the second and third spaces on the eastern end of the bridge. There are also 855 feet of temporary pile trestle, making the entire length of the bridge 2,815 feet. It is to be a through bridge, 16 feet wide inside of trusses, and is intended to accommodate both railroad and highway traffic on the same roadway. The grade is 22 feet above the mean water level. There is added the usual pile pier protection for the draw, and timber ice-breakers for all the piers.

METHOD OF CONSTUCTION.

The center line of the bridge and the position of the draw span with reference to the navigable channel having been decided upon, a line was run parallel to this center line and 25 feet distant from it up stream. Upon this latter line clusters of five piles were driven, approximately opposite the axis of each pier, and temporary platforms of plank about seven feet square were built upon them, some five or six feet above the water level. An observer on these platforms could easily oversee the work on the foundations. A transit line was then run across all of the platforms and the distance from center to center of each pier carefully measured with a light steel

tape and spring balance, and marked by a nail in each platform. These distances were repeatedly checked against possible displacement during the progress of the work.

The pile driving for pier foundations was then begun. The bottom was clay overlaid with more or less mud. The depth of water ranged from six feet to 22 feet. The piles of each pier, except the draw pier, were driven within an area of 14 feet by 40 feet, the size of the timber platform to be carried by them, and an average of 116 piles was driven in each. The draw foundation is 40 feet square and contains 329 piles. Most of the piles were elm, not less than 12 inches in diameter at the middle of their length, and were from 22 feet to 45 feet long. Their positions were readily found by measuring from the center on temporary platforms, and two slender rods nailed on the same on a line at right angles to the center line gave the axis of the pier. All piles were driven until they practically refused to penetrate farther under hammers of from 2,000 pounds to 3,000 pounds, falling at the last about 30 feet. They were banded to prevent splitting, and were generally left projecting above water from five to eight feet. They penetrated from 10 to 15 feet into the hard, clay bottom.

The piles were then sawed off as low as practicable, generally within six inches or a foot of the bottom, and in a few cases in the mud itself, by means of a circular saw on a long shaft, which ran in boxes fastened to a vertical timber, capable of being raised or lowered in the leaders of a floating pile-driver frame. The saw was driven by an engine on the float by means of a heavy belt making a quarter turn. The elevation of the saw having been decided upon, it was placed and kept in that plane by watching a mark on the arbor through a level placed on the temporary platform. As the water was liable to change in height from the action of wind and current, an assistant was required to be constantly on the watch while sawing was in progress, and the saw was raised or lowered whenever necessary. No difference of level of the pile heads of over one-tenth of a foot was afterwards found, and seldom was there any appreciable variation. Some 25 to 40 piles could be driven in one day and from 50 to 80 cut off.

The 11 timber platforms were 14 feet by 40 feet in plan and of different thicknesses, from two and one-quarter to six and one-half feet, according to depth of water, all made of 12x12-inch elm timber, laid close together, crossing in alternate courses, fastened with seven-eighths-inch drift bolts 20 inches long and covered on top with a course of three-inch elm planks spiked with 60d nails. To the deep water platforms another course of three-inch pine planks was added to insure greater tightness of the caisson, as the elm admitted water more readily.

Upon the timber platform were erected sides, made by spiking planks, two inches thick for shallower water and three inches thick for deeper water, upon vertical joists, thus making the platform the bottom of a large rectangular box or caisson. The joists were fastened at their lower ends to the upper surface of the platform, generally by simple toe-nailing, but for deep water by dovetailing into the platform planking. The height of the sides was such that they came above water one or two feet after they were sunk in place. The sides and bottom were calked with oakum so as to make the leakage under a head of three or four feet reasonably small. The dry pine swelled upon immersion and thus closed up tighter. Cleats for mooring lines were added on the outside.

From the elevation at which the piles were sawed off and the thickness of timber in the platform the distance of the bottom of

the masonry below the grade of the bridge was known, and the size and shape of the lowest course of stone was now marked out on the bottom of the caisson. Nails in the middle of the four sides gave lines of sight for placing the caisson.

The caisson was then towed to position over the piles, was located by two transits, one on shore or on another pier, sighting along the axis of the bridge, the other on the temporary platform before mentioned and sighting at right angles to the former, and was moored to guide piles driven close by, as soon as the caisson was located. Planks spiked to these guide piles and abutting against the sides of the caisson compelled it to retain its position approximately as it settled.

The lines for the bottom course of masonry were laid out to allow for two offsets in the footing courses of from six to nine inches each on a side before beginning the battered work. Stone-laying now began, generally with courses of 22 inches in height, the stone, which was Amherst sandstone, being taken from decked scows, swung to place by a derrick erected on a scow alongside, and handled by a steam hoisting engine. On the same scow was the mortar bed where two men were constantly employed in mixing Louisville cement mortar. The caisson settled gradually under the increasing weight of masonry; the water leaking in was kept down by a 30-inch centrifugal pump of Heald and Cisco's make, driven by a rotary engine on a small float. No attempt was made to keep the caisson dry, but the water-level was kept below one or two courses of masonry to give the cement time to set. Temporary braces, at first across the top, and later against the masonry in place, prevented the sides of the caisson from being forced in by the water pressure. Just before the caisson grounded its position was rectified by the two transits before mentioned, and it usually settled upon the piles within an inch of the desired position. In any case, by lifting out two or three stones it could be floated and readjusted.

As soon as the caisson was settled upon the foundation, and the footing courses completed, the center line of the bridge and the axis of the pier were marked on the masonry, and the base of the battering sides of the pier was laid out. The offset on the footing allowed any small error in location of the caisson to be readily corrected. The work then proceeded as usual to the completion of the pier. The thickness of courses ranged from 26 inches to 14 inches, and the stones were generally massive, some containing over one cubic yard. The masonry was all quarry-faced ashlar. The sides of the caisson could be torn away, as soon as the masonry was above water, and used in planking other platforms or caissons.

Nine of the piers were 6 feet wide just under the coping, 30 feet long from point to point, having a right-angled nose on each end, and 24 feet from shoulder to shoulder. All the sides battered three-fourths of an inch to one foot from the coping to the footings. The coping was 14 inches thick, and overhung 3 inches all round. The two piers at the ends of the draw were 8 feet wide and 32 feet long, and had copings 16 inches thick. The draw pier was circular, 31 feet in diameter under the coping, and battered three-fourths of an inch to one foot. Its platform was 40 feet by 40 feet, and four and one-half feet thick, on 329 piles. Its caisson was octagonal in plan, just large enough to contain the footing courses and pump, and was strongly braced to a center post, the lower part of which was allowed to remain in the masonry. Mooring lines and guide piles prevented the deep-water caissons, when first loaded, from rocking much from waves or swell caused by steamers.

INCIDENTS.

In two cases the platforms did not rest level when first sunk. Upon removing stone sufficient to float them, in one case a water-logged pile butt which had been sawed off and allowed to sink on the foundation, and in the other some small pieces of wood and drift stuff were removed by pike poles, directed by a laborer who went down for a few seconds in the muddy water. The caissons were then grounded correctly. A side of one caisson, insecurely fastened, separated from the bottom during sinking, resulting in the rapid submergence of the masonry then built; but the caisson sank on the piles, so that it rested level. Chains with dogs on the ends, such as are used for lifting stone, were lowered until the hooks caught under the timber platform. The side was then drawn down to place, and the water pumped out, when the caisson again floated.

MEN AND PLANT EMPLOYED.

The working time was about three months. The number of men employed varied from time to time, but the maximum number of those working by the day, which does not include driving and sawing off piles, and towing, was not far from fifty, distributed as follows:

Ten or 12 stone cutters.
Six men hauling stone to and from stone-yard.
One engineer for hoisting-engine on wharf.
Foreman and four men handling stone at wharf and loading scows.
One engineer for hoisting-engine on derrick scow.
One engineer for pump engine.
Two to three mortar mixers.
Foreman and four masons at caisson.
Three tenders and laborers at caisson.
One stone-cutter at pier.
Eight men building timber platforms.
Two calkers, one carpenter, one rigger and boatman, one time-keeper, one watchman, two water boys, occasional laborers to handle sand, etc.

There were two, and at one time three, pile-drivers, with crews, driving piles by piece-work, and one, or sometimes two, saws cutting off piles. A steam tug with crew of two men was constantly employed. The platform builders, pile-driving crews and sawyers completed their work in about one-half the above time.

Besides the plant mentioned in the last paragraph the contractor furnished and used two sling carts and one wagon, with eight horses for moving stone on land, one hoisting engine and three derricks on wharf, three decked scows for carrying stone, one derrick-boat at pier, one hoisting engine on same, one centrifugal pump and frame, one rotary engine and small scow to carry it, miscellaneous material, mooring lines, blocks, chains, tools, etc.

RATE OF WORK AND QUANTITY OF MATERIAL.

To show the rapidity with which the work progressed with this force we will state that at pier No. 5, after the piles had been driven in 11 feet of water and cut off at elevation 7.12 (mean water level being 18.00), the caisson with four feet of timber and six inches of planking, bringing the top of platform to elevation 11.52, was placed in position Saturday, September 3, was sunk to bearing on piles September 5, when the top of footing courses was at elevation 17.20 and the pier was completed to coping September 8, at

elevation 33.00. Amount of material in this pier to coping: Piles, 4,170 linear feet; timber, 30,240 feet, b. m.; masonry, 176.43 c. yards; bottom course, 10.5 feet wide, two feet high: next two courses, 9.5 feet wide. 3.7 feet high; base of battered work, eight feet by 32.95 feet.

Caisson for pier No. 12, in five feet of water: elevation of piles, 13.00; timber, 2.25 feet thick; caisson placed September 28, pier completed to coping September 30; masonry 134.24 c. yards.

All the copings were put on after the piers were otherwise completed.

The first seven piers were brought some two or three feet above water in 21 days after the first caisson was located, and two of them were also carried up to the coping within that time.

The amount of material used in the 12 completed piers was: piles, 51,156 linear feet; timber, 363,120 feet, b. m.; drift-bolts, 13,120 pounds; masonry, 2,745 c. yards.

The engineering force comprised a chief engineer, a resident engineer, two assistants, one rodman, and an inspector of pile-driving.

WATER-WORKS FOR SMALL CITIES.

BY G. W. PEARSONS, OF KANSAS CITY, MO.

KANSAS CITY, MO., *Dec. 20, 1881.*

Michigan Society Surveyors and Engineers:

GENTLEMEN,—I have been honored by a request to furnish your society a paper on water-works, which I here present by the hand of H. C. Pearsons, of Grand Haven.

Having in preparation at the same time a detailed paper on the same subject, and thinking a general review of the whole field more interesting at first, I have prepared this paper rather in popular than in scientific form. Fifty years ago the Michigan railroads were built by laying the rails crosswise of the road. Rubber boots were not invented and the surveyor was liable to get his feet wet; but he followed his compass through the woods, extending the domain of civilization, sometimes even doubting whether it always pointed due north. Very few, however, were so ungrateful to that beautiful instrument as to hint at any doubt of its accuracy in their survey bills.

Gradually the country filled up and a new kind of railroad was introduced, in which the rails ran lengthwise of the road. With them came great bridges, deep cuts, heavy embankments, tunnels, etc. Some of the surveyors got new-fangled compasses with spy-glasses on them. These men were very particular about their work and we began to hear about engineers—not engine drivers, but these men with their new-fashioned compasses—laying out new lines through the country, sometimes straight, sometimes crooked, but in either case intentionally so. This has gone on till the title of engineer may mean almost anything, for the growth of the country has demanded skilled men to lead its diverse industries, and under the broad title of engineers are ranked the men, who, in the mine or machine shop, forge or field, factory, mill, or ship-yard, have gained their leadership by intelligent study and experience in the particular work they have had to do.

Do we want a bridge, factory, mill, vessel, railroad, no matter what, no matter where; here or in some other State is the man we want to build it. No matter how far off he is, these new roads reach everywhere, and the distance we have to go for the right man is of no particular consequence; the right man is, and this man is an engineer, whether he got his diploma from the college or workshop.

The subject of this paper pertains to an industry caused by men gathering into close communities. Like other branches of engineering any one can take it up, and like them he will have a much smaller idea of his knowledge of it after ten years of experience than he had at five. It is of more general interest than most

branches from its dealing directly with the supply of large communities who, while they are unable to study detail, are personally interested in obtaining a general idea of it.

SOURCES OF WATER SUPPLY.

Primarily, all water supply is based on rainfalls distributed over almost the whole earth, stored in lakes, flowing in rivers, held in the ground and issuing in springs. Springs, rivers, and lakes form the first or natural available supply. Among the artificial sources are wells, more generally available as regards distribution, each furnishing a limited supply to a limited number of consumers. But in cities these become, far sooner than is generally supposed, not only unwholesome but in many cases dangerous. The black death in London was found to be largely due to poisoned water from wells, many of which were supposed to be of unexceptionable quality.

A well sunk in ordinary ground drains from all directions, lowering the water in the soil which is nature's filter and for a long time keeps back noxious matter; but when cesspools, privies and streets are in close proximity, as they must be in towns, the surface of the ground becomes saturated with more noxious material than oxidation can carry off. Sooner or later, in increasing quantities the poison finds its way through the soil to the well, and in its sparkling clearness hide the seeds of disease, notable among the varieties of which is typhoid fever, always the result of poison from human waste, in some of the many forms, either liquid or gaseous, which attend its decomposition, and the more dangerous from its unsuspected presence.

The qualities most desirable in water for domestic use are softness and clearness. Purity is a relative term. Pure water is not found except by the research and careful work of the chemist. Water is nature's great solvent, and more or less of some mineral or organic substance is always held in solution. Commonest among mineral substances is lime, generally as a carbonate or sulphate, making the water hard, but very probably when not in too great quantity, better for drinking. Water containing not over five grains of lime in a gallon is termed soft. Many streams come within this limit or near it, but few springs or wells.

Streams are liable to carry more vegetable and animal matter than wells or springs, but when the enormous mass of water passing through even a small river is considered, it will be readily understood that the impurity shown to superficial observers is more apparent than real, and we often find that the water we thought the poorest is really the best.

The subject is too large for more than mention and the joint study of the chemist and engineer is required to properly select a supply from different available sources.

Lakes are nature's reservoirs, and when available may furnish supplies worthy of the envy of less favored localities. But even here the study cannot be always omitted. Few are aware of the enormous amount of water used by large towns. Chicago uses two hundred and eighty thousand tons of water per day, or rather wastes it, for in American cities from one-half to four-fifths of all the water used is needlessly wasted.

Artificial reservoirs come next, storing water for use, either from the necessity of providing supply for the dry season, from the requirement frequent with waters from rivers bearing sediment of time and storage to settle before it is used, or from the necessity of raising it to a height from which the force of gravity will cause it to flow to the required localities for distribution.

FILTRATION.

One of the most common errors in the study of water supply is found in the consideration of this subject. Many persons suppose that by some kind of filtering arrangement the muddy water of our streams can be at once made fit for use. This is not so. Mud must be separated from water by subsidence before the water can be filtered, and then it is very generally found that filtration is unnecessary. While for the use of families and sometimes even for towns filters are practicable and valuable, they are less generally applicable than supposed.

A bad taste is frequently found in water from lakes or reservoirs, coming on some time in the summer and lasting from a few days to some weeks. This taste causes much trouble and distrust, is generally worst from shallow lakes or reservoirs and seems to be caused by a vegetable growth, very disagreeable but not necessarily hurtful. If, however, it is found that the drainage from closely inhabited areas mingles with the water supply, the case is one for grave apprehension.

DISTRIBUTION.

The close proximity of houses in towns, while it destroys the availability of wells, makes it practicable as well as necessary to resort to the use of pipes carrying the supply to any desired locality. To do this it is necessary in some way to resort to power. If we have available a supply of water at a sufficient elevation the power is found in natural gravity, and it will pay to bring water a considerable distance in pipes to make this available rather than to use artificial power to raise it from a nearer source. The distance it will pay to go depends on many considerations, but generally from the great cost of large pipes, it will be found less than supposed.

Consider the water stored at such an elevation as will enable its distribution by pipes. What must this elevation be? Of course we must flow the higher part of the town. But if, as is sometimes the case, small areas containing few dwellings are considerably higher than the mass of the town, it may be impracticable to give them as much force as they would desire without more cost than the extra height will warrant.

In general terms it may be said that it is desirable to have the source of supply from 80 to 100 feet above the streets to be supplied, while if 200 feet or more is available, the force of the water will be sufficient to throw fire streams without the use of hand or steam fire engines.

A head of more than 100 feet is not generally desirable for domestic supply, especially if the water has to be raised by pumping, as the cost of raising it varies directly with the height raised.

THE SIZE OF PIPE

is limited by considerations of economy, and it becomes important to know how small pipes can be used. Water is retarded in its flow through pipes by its friction on the sides. A pipe of six inches bore has one-half the surface of one of 12 inches, but holds only one-fourth as much water. The result is that the larger pipe under the same head has the fast current and therefore carries more water according to its area. Any pipe under similar conditions carries over five and one-half times as much water as one of one-half its inner diameter (5.67 nearly). The frictional resistance causes loss of head. Knowing this we so arrange the pipe system that we can afford such loss as the case will admit. With a loss of

ten feet head per mile the following pipe, supposed to be ordinarily clean and smooth inside, will deliver approximately:

Size of pipe.	No. of gallons per day.
4-inch	62,000
6 "	186,000
8 "	351,000
10 "	657,000
12 "	1,051,000
16 "	2,160,000
20 "	3,780,000

One-half of this flow causes one-fourth of this frictional loss; double the flow four times the loss.

The amount of water formerly supplied by water-works was comparatively small, and bored wooden logs were used as conduits to a large extent. The present use of water, including that used in manufacturing, ranges from 60 to 150 gallons per day for every inhabitant of the towns supplied, and the pipe system must be sufficient to carry this quantity or must be so arranged that it can be increased when needed. Wooden logs are too small and weak for the present requirements and the pipe most in use now is cast iron, very expensive but durable. Wooden pipe is now made at Bay City, Mich., which by banding with wrought iron is made capable of carrying almost any required pressure, is much cheaper than cast-iron and a very good substitute.

Wrought iron pipe lined and covered with hydraulic cement is made at Jersey City and other localities. This is largely used, is cheaper than cast iron, but not so cheap as wooden pipe. A wrought iron pipe made by rolling thin sheet iron with a bath of hot asphaltum around a central core is now being made in New York and San Francisco. This is claimed to be a better substitute for cast iron pipe than either the wooden or wrought iron and cement pipe. It is not yet made in this part of the United States but probably soon will be. These are the principal water-pipes now available.

WATER SUPPLY SYSTEMS.

Till within a few years the reservoir system of water supply, either from natural or artificial storage, stood almost alone. Curiously its best economies seem to be for very small or very large works. Between these extremes the comparatively new Holly or direct-pressure system is finding remarkable favor, its great value being that dispensing with reservoirs it can give any desired pressure in the pipes by the constant action of the pumping machinery, and in towns of medium size do away entirely with the need of fire engines, the more powerful engines of the water-works being always ready and every hydrant the practical equivalent of a steam fire engine.

The reason why very small towns cannot afford the Holly system is that it requires constant attendance. Where water power is available for pumping this objection does not apply, and towns of as few as 1,000 people can use it economically. When circumstances render it necessary for other towns of small population to construct water-works, close economy is against the use of the Holly system on account of the cost of the engineer's salary, the smallest works requiring two men; while by constructing tanks on a sufficient elevation one man, using but a small part of his time, can do all the necessary work, not only of running the engine, but of attending to the mechanical and financial departments of the work. This,

however, does not generally give fire protection, and in our fast-growing American towns can be best considered as the introduction to the far more efficient direct supply system. How far in the other direction the direct supply system is economically available is yet unknown, but it is evident that in very large cities the additional pressure required for fire streams by causing with the necessity of increasing all the usual flow a corresponding increased power must come to a point where fire engines can supplement usual pressure more cheaply.

For instance, suppose the works give a domestic supply of 4,000 gallons per minute, or say 6,000,000 gallons per day, with a head of 100 feet at the pumps, using say 120 horse power. An alarm is given and in one minute double this pressure is required. This alone calls for double the power, but added to this are the increased flow of water through two or three thousand taps, and the fire streams, so that the power called for may be three times that in ordinary use. No boilers can carry this amount of surplus steam and a greater or less time is lost in waiting for the pressure to rise, which is not the case if a few steam fire engines are used capable of getting up steam very quickly and calling on the supplying machinery simply for what water they want, with no increase of pressure. The objectionable delay can also be met by separating the pipe system into several parts, the machinery being so arranged that additional pressure can be given to any of them by calling on the reasonable available surplus of the whole. By this means the city of Chicago could be supplied as fully and certainly as the town of Kalamazoo. But the larger cities are already supplied by the reservoir or stand pipe systems, and time must show, with the growth of smaller cities, what cannot now be determined,—the economical limit of application of the direct pressure system.

ECONOMY OF OPERATION

consists in minimum cost of attendance, fuel and repairs. The study that has been given to all these points is great; not so great, however, as not to leave room for active competition and the closest study on the part of engineers and builders of machinery. It is easy to understand that an engine constructed to run with greatly varying conditions of power and speed cannot be so economical in either respect as one calculated to do steady and uniform work at any rate found in practice to give the best results. So great was this discrepancy supposed to be that it formed one of the principal early arguments against the use of the direct pressure system. Such, however, has been the improvement in this system that its later results surpass the average of those obtained by the older systems and come close to their best,—would have passed them had not great improvement been made in them also.

DUTY.

The present study of pumping machinery largely aims at obtaining the minimum consumption of fuel. In engines of small power this may be easily carried to excess; that is as regards the complications resulting from condensing and compound engines.

A good common high-pressure engine well adjusted will give one horse-power for each three or three and one-half pounds of coal per hour. A very high class compound condensing engine, costing twice as much and requiring corresponding skill to run it, may do the same work on two pounds of coal per hour, although this result is very seldom obtained with small engines; but

the increased first cost and increased skill required for attendance will be found to render the saving of fuel in small engines of doubtful economy except when fuel is high-priced.

WASTE.

It is of vital importance that the magnitude of this evil be thoroughly impressed on a community when water-works are first put in operation. Water costs money because every gallon is distributed by the outlay of capital, fuel, and labor. A single faucet left open may waste from 5,000 to 10,000 gallons per day, and the frequent expense of enlarging works and the continually growing bill for fuel, attendance and repairs is in a great measure due to the people not being impressed with the fact that to secure real economy each individual must see that he is not stealing from a fund that must be kept up by the whole town whether he pays his quota of it or not.

METERS

are used as with gas and are the only sure preventive of waste, charging each consumer for just what he uses. They are, however, costly and annoying, and communities dislike them so much that few towns use them to such an extent as they should. A waste preventing device is now being made, which without the objection to meters checks unnecessary waste, and will relieve communities from a large portion of the present loss without great expense.

Many more topics might be taken up in the consideration of this subject, but this paper is already much longer than intended and touches on the principal points.

REFORM SCHOOL FOR GIRLS.

BY BURTON KENT, OF ADRIAN, SUPERINTENDENT OF CONSTRUCTION.

The Michigan Reform School for Girls at Adrian is located upon a swell of land just outside the corporate limits of the city, one and one-half miles N. N. E. of the business center of the town; the tract of forty acres of land donated by the people of Adrian to the State, covers the summit of this elevation the highest point of which is a little south and east of the center of this tract, the descent each way being quite gentle except toward the northwest where it is more abrupt, the land falling off some twenty feet at the northwest corner.

A thrifty growth of young timber covers about one-fourth of the tract along the west side, protecting the buildings against the west winds. Roads bound the State lands on the north and east; the latter road upon which the buildings front is the main road to Tecumseh.

The buildings erected and being erected are four cottages, a boiler-house and a chapel. Two of the cottages and the boiler-house are completed and occupied; the other buildings will be finished by the first of June next. The cottages are L shaped with front elevation. The wings are two stories with basement. The front is three stories. Each cottage is complete in itself, its pupils with the officers and assistants constituting a household independent of the others, the pupils being classified according to their characteristics and capabilities. The buildings are all warmed by the low pressure steam heating system. The pipes are of iron encased in the Wickoff patent wooden steam-pipe casing. The pipes enter the basement, pass around it to the radiators, which are both direct and indirect, the latter being located in the basement and the former in such parts of the building as the necessities seem to require. The buildings are all substantial structures with brick and stone walls, with a slate roof. The architecture is modern and well adapted to this class of structures, and is at the same time well characterized as ornamental.

The water supply is derived mainly from a well, augmented somewhat by the rain collected from the roofs of the buildings and conveyed into a cistern 100 feet long and nine feet in diameter, having the capacity of about 1,500 barrels. The well is 16 feet in diameter and 15 feet deep, fed by copious springs. The water from these sources is pumped by steam into two tanks, one for well water and the other for rainwater, elevated in towers adjoining the boiler-house, 50 feet above the grade of the grounds; thence it is conducted in separate iron pipes to the buildings where needed.

The sewer system of the institution consists of a main sewer

2,400 feet in length, of eight-inch sewer-pipe, with joints effectually closed with Portland cement, laid on a grade of six-tenths of one foot in 100 feet for twenty-one hundred feet, to the bank of the river; thence to its discharge into the river the descent is more rapid. Frequent openings left in this line are brought to the surface by tile drainings to facilitate observation and ventilation. Through these openings can easily be inspected its workings and condition. Near the confluence of its branches, a catch-basin with a grate, prevents obstructions from passing into the main sewer. The most important ventilator of this sewer is a pipe near the upper end passing into the chimney of the furnace of the boiler, affording thorough ventilation, drawing the foul air from the whole length of the sewer and cleansing it thoroughly of all impure gas.

The daily discharge of house sewage from the kitchen and laundry is discharged into a grease trap, thence into the vault of the water closet, and there retained through the day by a plug in the discharge pipe; in the evening it is liberated from each at about the same time, and it rushes down through the main with a velocity sufficient to scour it thoroughly and to carry along anything that can find access to the pipes. This discharge will be supplemented in warm weather by a flushing from the tanks that will cleanse the whole line thoroughly each day.

The dryness of the soil here is all that can be desired, permitting the immediate absorption of all water falling upon the surface, leaving it dry and healthy. No provision has been conceived necessary to admit rainwater to the sewer; nothing can enter it except through the small pipes, and all sewage entering it is completely under the control of those in charge of it

COMPASS DEVIATIONS ON VESSELS AND THE CONVERSION OF COMPASS COURSES.

BY H. C. PEARSONS, UNITED STATES INSPECTOR OF STEAM VESSELS.

FERRYSBURG, MICH., *Jan. 5, 1882.*

Mr. President and Gentlemen of the Michigan Association of Surveyors and Engineers:

Agreeably to invitation through your secretary I have prepared an essay on a subject of my own choice to be read on this occasion. I introduce the subject of Compass Deviations on Vessels and the Conversion of Courses.

This subject, while perhaps a little foreign to those usually considered by the civil engineer, is yet intimately related to land surveying and navigation, a work which is only another kind of surveying. Besides, as vessel building comes within the pale of the civil engineer's work, I hope this topic may not be altogether unworthy of his attention.

The magnetic needle is older than any authentic history concerning it, yet only within the last 50 or 60 years has it been studied scientifically or have the laws governing its action been known; nor yet do we know what this power is that gives direction to the needle, nor anything of it but the fact of its existence and a few of the modes of its action. We can only class it with those powers whose effects we see, as in the building of a blade of grass or a mountain forest, in the moving of a railroad train or the gliding of a river across a continent. We can only call it one of the imponderable agents by which God actuates passive matter. In this paper I can only call to mind a few of the points of knowledge attained concerning the magnetic needle, with some of the difficulties encountered in their attainment.

1. The earth has come to be regarded as a vast magnet, having positive and negative poles like an ordinary magnet, and with magnetic intensity to some extent variable in different geographical positions, but increasing generally from the magnetic equator to the magnetic poles.

2. On the magnetic equator, which roughly coincides with or is analogous to the geographical equator, the magnetic needle takes a horizontal position at right angles to the magnetic equator. North of this the north end of the needle dips or inclines to the horizon, the angle of the dip increasing from the magnetic equator with the magnetic latitude till at the magnetic pole the needle stands vertical. The rate at which the dip increases from the magnetic equator is at first nearly two degrees of dip for one degree of latitude, falling off gradually till near the magnetic pole, where it is

only about thirty minutes for a degree of latitude. The reverse takes place south of the magnetic equator, the south end dipping, etc.

3. Different kinds of iron have different magnetic properties. Hard iron and steel are slow to receive the inductive magnetism of the earth and as slow to part with it. Indeed, if while charged with magnetism these metals are worked in a cold state, as in the riveting of plates or finishing iron in a lathe, or in rolling cold plates in the bending rolls, a considerable portion of the magnetism in them becomes permanently fixed, whence arises the polar magnetism of iron ships. Soft iron, on the contrary, is quickly charged with induced magnetism, and it may be as quickly demagnetized.

4. The plane that is perpendicular to the dipping needle is called the neutral plane from the fact that an iron bar lying with its length in this plane is not affected by the earth's magnetism. Indeed, if a bar of iron with its length lying in this plane be smartly hammered or violently beaten, any magnetism that may be in it is as readily shaken out as we would shake the dust out of a carpet. If the bar be turned from the neutral position towards a parallelism with the dipping needle it will immediately become magnetic, and the intensity of this induced magnetism will attain its maximum when this parallelism is attained, the end towards the equator having the same kind of magnetism or polarity as that in the same end of the needle, while the polar end of the rod will have the same as that in the corresponding end of the needle. This property of magnetism in soft iron has cost a vast amount of trouble, perplexity, and dismay in the long struggle to obtain the mastery of the magnetic behavior of the needle on iron vessels. Thus a horizontal iron deck beam, when lying in an east-west direction, is in the neutral plane and therefore, having no magnetism, has no effect on the needle. But on a change of the vessel's direction, or on her being heeled over to one side, this beam comes out of the neutral plane, becomes immediately magnetic, and like an enemy from ambush joins its disturbing force to that of the vessel.

5. That component part of the magnetic force that operates to orient the needle is called the horizontal force, since it acts in a plane parallel with the horizon and perpendicular to the plane of the magnetic meridian. This part of the magnetic force is smaller as we go towards the magnetic poles, for the reason that though the total force increases with the latitude, the horizontal component varies with the cosine of the dip, resulting in the feeble directive power of the needle sometimes seen in high latitudes. The vertical component gives the needle its dip and varies as the sine of the dip, so that this force increases as we go towards the magnetic pole. A knowledge of the intensity of the horizontal or directive component is of the first importance in the study of terrestrial magnetism. Its relative intensity at different geographical points has been found from the number of oscillations a disturbed needle will make in a given time, precisely as the force of gravity is determined from the number of oscillations of a pendulum in a given time.

6. The variation in the relation between the directive force and the induced magnetism of soft iron resulting from the vertical component gave great trouble in going from lower to higher latitudes, as it increased the compass errors, the directive force being diminished and the disturbing force being increased.

7. It is customary at sea to carry the compass in the stern of the vessel. In turning the vessel around with the compass thus located, the needle generally follows the head of the vessel. Thus, if the head is turned toward the east the north end of the

needle will also turn towards the east until the vessel's head is east magnetic, when it will have attained its maximum deviation in that direction. As the vessel's head goes thence to the meridian, either north or south, the needle will go back to its starting point, and as the vessel's head goes from the south to the west the needle will also move towards the west, attaining its greatest westerly deviation when the vessel's head is west magnetic; thence as the vessel's head goes to the meridian the needle will also start on its return to the magnetic north, where they arrive at the same time.

8. These conditions are exactly reversed when the compass is carried in the forward end of the vessel; and here I may say that in most steam vessels on the lakes the compass is carried forward, or at least forward of the machinery. The conditions above mentioned are somewhat modified by the direction given to the keel during the building of the vessel, particularly if of iron, because the axis between the magnetic poles of the vessel arranges itself approximately in the magnetic meridian. Each vessel, therefore, has an individual magnetic character of its own, so that the behavior of

ERRATA.

Page 35, paragraph 9, tenth line, read "sign" for "sine."

Page 36, in heading over diagram, read "Graphical" for "Geographical."

Page 37, under head of Definitions and First Principles, first paragraph, last line, read "E. 60° S." for "E. 30° S."

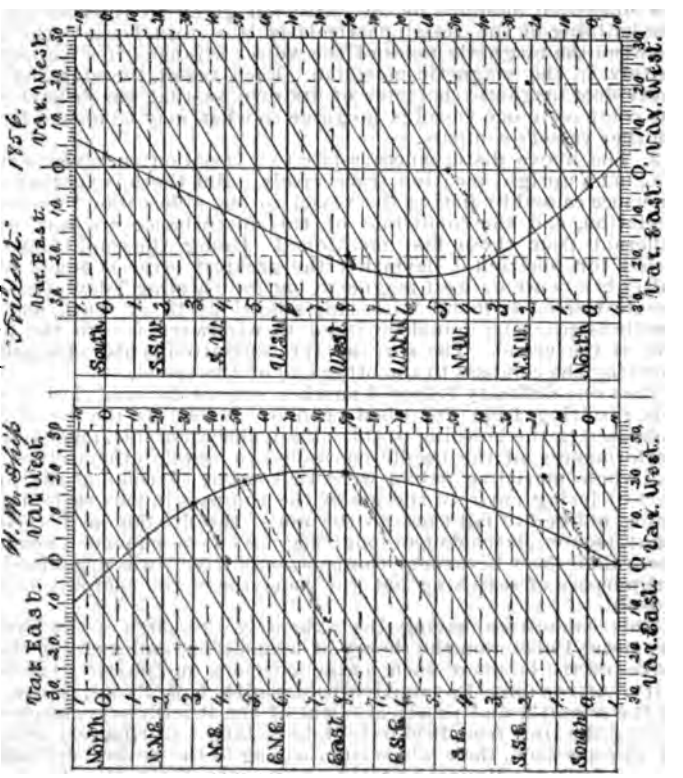
being obliged to fall back on the use of the five famous L's,—lead, light, lookout, latitude and longitude. As a consequence a committee, called the "Liverpool compass committee," was organized for the purpose of searching out the behavior of the compass on iron vessels.

This committee, having the exhaustive research of the French geometer Poisson on the theory of magnetism, and availing themselves of the labors of such mathematicians and physicists as G. B. Airy, Astronomer Royal, Archibald Smith, F. J. Evans, Gauss, and of the scientific and practical talent of the British navy, succeeded, during the time from 1856 to 1874, in making a satisfactory solution of this question, their labors culminating in the several editions of the "Admiralty Manual," published by order of the Commissioners of the Admiralty and promptly incorporated with the standard nautical literature of all maritime people.

As an outgrowth of all this research two methods of deducing the true course from the disturbed compass were introduced. One by compensating magnets, *i. e.*, by opposing fixed magnets to the magnetism of the vessel in such a manner as to bring the compass needle back to its normal position. This plan was proposed by the Astronomer Royal, G. B. Airy, and extensively employed in the merchant service and to some extent in the navy. Another plan was that of

deducing the true course from a table of compass errors found by swinging ship and comparing the readings of the compass with the actual amount of the ship's angular motion as found with a compass on shore, and away from the ship's magnetism, the difference between the readings of the two compasses being the deviation of the ship's compass for the corresponding heading of the ship. These differences being found and tabulated for a sufficient number of points around the circle are called a deviation table of the ship's compass. Without discussing the relative merits of these two methods it is sufficient to say that the latter is chiefly in use, and it is this method which we propose to illustrate with the following

DIAGRAM FOR THE GEOGRAPHICAL CONVERSION OF COMPASS COURSES.



This diagram shows two scales,—a vertical and a horizontal one. The vertical scale represents azimuth, and is to be read downwards, such reading corresponding to the reading of the compass card from left to right as we read a watch dial. This scale may be read in points on the left of the page or in degrees on the right, reference being made by the horizontal lines across the page. The two horizontal scales at the top and bottom of the page are variation and deviation. The line drawn through the zero of these scales and vertically through the page represents the magnetic meridian.

Westerly (left or port), deviation is set off to the left, and easterly (right or starboard), deviation is set off to the right of this meridian. Not so with variation, which is set off from the magnetic meridian in a direction contrary to its name, the reason for which will appear presently. The astronomical, sometimes called the chart meridian, is represented by any line drawn vertically through the page and parallel with the magnetic meridian, and the figure of the scale at the top and bottom of the page, cut by such meridian is the corresponding variation.

The compass errors having been found as above indicated and set off to the right and left of the magnetic meridian on their corresponding courses per compass, a fair curve is drawn through the points thus set off. This is called the deviation curve of the ship's compass, and whenever this curve is used for the conversion of courses the compass must be in the ship in precisely the position it occupied when the curve was taken.

The reason for placing the variation scale to the left of the zero point will be seen when we remember that with say easterly variation the magnetic meridian is to the right of the true meridian. Moreover this arrangement brings variation and deviation of the same name together by addition and of different names by subtraction. The oblique lines uniting the two scales are for the purpose of increasing or diminishing the reading of the vertical scale by the algebraic sum of deviation and variation. These lines unite points of the same numerical value on the two scales. To help us n the use of this "diagram" we bring to mind a few

DEFINITIONS AND FIRST PRINCIPLES.

Azimuth is ultimately reckoned from the left to the right as w read the dial of a clock, but there are different zero points in use The geodetic surveyors reckon from the south meridian continuously around the circle from left to right to the place of beginning, thus having but one sign to their azimuth. The land surveyors reckon from both meridians and in both directions, right and left, thereby introducing four signs into azimuth, so that in reckoning from either meridian we have +, —, +, —. The navigators, too, recognize this notation in making up their "day's work," and in shaping the course of a ship, but in defining the azimuth of a heavenly body for the purpose of finding the error of the compass they reckon from the elevated pole, both to the right and left 180 degrees, while the officer of the deck reckons from all four of the cardinal points, and in both directions, right and left, from each point. Thus the navigator, after reducing an observation on the sun for azimuth, will perhaps say, "the sun bears N. 120° E." The geodetic surveyor would say, "the sun is in azimuth 300°." The land surveyor would say, "the sun bears S. 30° E.," while the officer of the deck would say, "the sun bears E. 30° S.,"—all equivalent expressions.

When the needle is deviated to the right of its normal position the reading is too small, and too large if deviated to the left.

A compass on board a vessel is always under the influence of two forces, the magnetism of the earth and that of the ship. The effect of the former is constant while the effect of the latter is variable with the heading. The bearing given by the ship's compass will be called simply the "compass bearing," while the bearing indicated by a compass ashore and away from the influence of the ship's magnetism is called the "magnetic course" or bearing; whence "magnetic course" differs from chart course by "variation," and "compass course" differs from "magnetic course" by "deviation," and

from chart course by the algebraic sum of variation and deviation.

Variation can be reduced arithmetically, for it is constant for all headings of ship, but not so with deviation. It changes even while the ship is turning, so that no scheme of numerical reduction can avail us and the graphical method becomes a necessity. Moreover, by the method which I have devised the perplexing consideration of eight algebraic signs is avoided, viz.: four for azimuth, two for variation and two for deviation, and we reduce for both variation and deviation at one move on the diagram. With the above explanations we take up the following

PROBLEMS.

The deviation curve in the diagram is that of H. M. ship "Trident," swung for deviation in 1856, the ship being on an "even beam," *i. e.*, upright transversely, and compass in the stern.

1. "To shape a course," the variation being known.

Example.—Being off the mouth of the Columbia river, var. 20° E., I wish to sail per chart due east; required my compass course.

Through the given var. draw a vertical line to represent the "local" meridian. On this meridian take up the required chart course (in this case due east), and project on to the curve by lines parallel to the oblique lines of the diagram. The point thus found on the curve (in this case N. E. ¾ E., or N. 4¾ P. E.), is the required compass course. (The projection is indicated by arrow points.) If I should want the compass course that would "reverse ship," *i. e.* take the ship over the back track, I take up the reverse chart course (west), on the local meridian (see opposite page of diagram), and as before project it on to the curve, when I find W. ¼ N. is the required compass course to "reverse ship." (The projections are indicated by arrow points.)

2. To find the course "made good," *i. e.* the chart course attained by sailing on any compass course, the variation being known.

Example.—Sailed north per compass, variation 20° W.; required the chart course attained, or, in seamen's phrase, required the course "made good."

As before, draw a local meridian through the given variation and project the compass course on to this meridian, from the curve. Thus we find N. N. W. ⅛ P. W., or N. 2⅛ P. W., the equivalent chart course. Again, south per compass, "makes good" per chart, S. by E. ½ E., or S. 1½ P. E.

LEEWAY AND DRIFT.

If in addition we are required to reduce for leeway or drift or both, we have simply to count up or down the vertical scale the amount under consideration, up for left or port, down for right or starboard hand leeway, and always on either the magnetic or the local meridian. In finding the "course made good" this reduction is made after the compass course is reduced, but in "shaping course" it must be done before the course is projected on to the curve, and with a sign contrary to its name. Thus in "shaping course" if you expect to drift to left you must bear to right.

3. To find the actual change of course from apparent change per compass.

Example.—Change course per compass from south to east eight points; what is the actual change of azimuth?

Project both compass courses on to the magnetic meridian and note the distance between the points thus found. Thus south per compass is S. ¼ W., per magnetic, and east by compass is S. 6¼ P. E. per magnetic course, so that the actual change in the ship's course is but 6½ points.

Again, change course of ship from N. 3 P. E. to N. 3 P. W. per compass; required the actual change of course.

N. 3. P. E. per compass is N. 4¼ P. E. per magnetic compass, and N. 3 P. W. per compass is N. 4¾ P. W. per magnetic compass, *i. e.* a change in her apparent course of six points as indicated by ship's compass has produced a change of nine points in the azimuth of the ship's course. In the former case the needle followed the ship's head, or rather ran forward of it, making the apparent change of azimuth too great, while in the latter case both readings were too small, so that the apparent changes were too small. It was not necessary to consider variations in these questions as it is the same for all headings.

From the discrepancies between the real and the apparent course of a ship as indicated by the foregoing examples we see how vitally important it is for the mariner to know at all times the place of his needle and to know the laws of its movements, so as to be able to anticipate a change of its direction, Uncertainty in the place of the needle near the north and south points of the compass is of all its erratic wanderings the most prolific of danger, and it has been the cause of some of the sorest disasters known in the history of shipwrecks.

Heeling deviations can be set off from the deviation curve precisely as horizontal deviation was set off from the magnetic meridian, and the reductions effected in the same manner, but this paper is already too long to admit of the treatment.

DRAINAGE ENGINEERING.

BY R. C. CARPENTER.

The increased production and healthfulness that arise from the construction of thorough drainage works will render them a profitable undertaking in most localities. Whether the drainage be thorough with a complete system of main and branch underdrains or partial with only a few open ditches, accurate knowledge of the fall to be obtained and the direction that must be taken at various points must be known before commencing the work, otherwise mistakes are liable to occur that will render the whole system a failure. The attempt to construct a system of drains without an accurate preliminary survey usually results in partial or complete failure, and where drainage has long been practiced all admit that a good survey is necessary to insure good work. In most portions of this State, however, people have not had sufficient experience to learn that the services of an engineer are necessary in such a simple operation as the construction of a ditch, and they will probably only acquire that experience through a few costly failures. On account of the great amount of drainage work that ought to be done, this branch of surveying promises in the future to provide work for many. In order to encourage the employment of skilled surveyors and engineers accurate levels must be taken, estimates made with skill and accuracy, and operations generally performed in such a manner that there can possibly be no failure. The people must be made to feel that the pay of a surveyor is a cheap insurance to secure immunity from failure. This paper treats only of agricultural drainage.

SURVEYING FOR UNDER-DRAINS.

Surveying for drains of necessity involves running a line of levels. It is also desirable that it should include a compass or transit survey of the lines that maps may be made and its location fixed. It is needless to enter into the details of this survey. The best location can in some instances be determined by the eye, but usually it is necessary to make a preliminary survey with the level alone. The important considerations in location are first, direct line and proper amount of fall between the area to be drained and the outlet. In the regular survey it is my practice to set station or section stakes at a uniform distance of 50 feet, and if possible, numbered from the outlet. The distance from station to station is perhaps immaterial, but should not greatly exceed 50 feet for under-drains, especially if the grade is light. In some instances a shorter distance, for instance two rods, and in other cases a greater distance say four rods, will give equally good results in practice. The lighter the grade the shorter should be the distance between the

stakes. The reason for this is evident; as an illustration, on a grade that rises three or four tenths per station a variation in the bottom of one inch from the grade line, although detrimental, would not seriously impair the drain. On the other hand a variation of the same amount on a grade of one-half-tenth per station might, with small tile, entirely ruin the drain, and in any case would seriously impair its usefulness. The station and angle stakes are set directly on the line of the proposed drain. Three to five feet (for enough not to be disturbed in excavating), to one side of each of these stakes are set a grade peg and a record stake. The levels are taken on the grade pegs. These should be driven so that their tops are level with the ground. The angle stake is considered a (+) station when occurring between station stakes, and the station stake beyond it is measured from the one preceding, the same as though no angle intervened. This practice is necessary in order that the number of stations may be a correct index to the distance.

SURVEYING FOR OPEN DITCHES.

In this case, although accurate work to grade is desirable, it is not so essential as in the case of under-drains; moreover, after the work is constructed obstructions or irregularities in the bottom can readily be detected by the riffles caused. For such work it is not customary to set station stakes closer than twenty rods, but my own experience has taught me that it will pay to set grade stakes at least once in ten rods. The cost of setting stakes once in ten rods will be but little in excess of setting them once in twenty rods, and will afford means of doing the work much more accurately. For township or county drains the law prescribes the minimum amount of work that must be done on the survey. As the work of construction is done by contract it will be necessary to establish benches near the line of the ditch to test any accidental or intentional disturbance of the grade pegs. To accomplish the same end care should be taken that the top of the grade pegs is driven flush with the sufrface of the surrounding ground. A grade peg should also be set near each angle of the drain. The stakes set should be the same as for under-drains, viz.: one set to determine the center line of the ditch, and a grade peg and record stake to one side removed far enough to avoid disturbance.

ESTABLISHING THE GRADE LINE.

The depth of an under-drain should in no case be less than two feet. It will be found that drains with a depth of from three to four feet work most efficiently and give the best satisfaction. In establishing the grade the object must be to maintain a continually ascending grade which shall never approach within two feet of the surface, and which will give a minimum amount of cut. Frequent changes of grade, if not of extreme amount, although detrimental, will not seriously impair a drain because of the short lengths of the tile piping used in drainage. The method of establishing a grade line from a profile requires too much time for this branch of engineering and moreover cannot be done on the field. The method I employ is to determine by inspection of the column of elevations that average rise for a number of stations which will give sufficient depth at any station and at the same time appears to give the minimum amount of work. Starting with the elevation of the outlet in the column marked elevation grade, add for each station the average rise and set the results in the column for El. grade. A check on this result applying to a uniform grade or single incline is that the El. grade is equal to the grade at first station on that incline plus the number of stations on the incline

multiplied by the grade per station. This process continued will serve to establish the grade line for the whole drain. The cut is the difference between the elevation of the grade and elevation of surface and it should be marked plainly on the record stake. As it is important that the workman should know at what stations a change of grade occurs, at such stations I use an arbitrary symbol on the record stake in addition to the figures marked at other stations. For open ditches the same method is necessary. The only consideration respecting depth to be observed is that it shall be sufficient to afford the necessary water-course.

SIZE OF TILE.

The engineer locating the under-drain should specify the size of tile needed. To do this will require the exercise of considerable judgment, for the conditions in different cases are seldom the same. The problem of determining the capacity of a line of tile is very complicated and perhaps will never be solved except roughly and approximately. It is probably true that it would be impossible to lay two lines of tile piping that would have even very closely the same capacity, and when we consider the imperfect manner in which they are usually laid it is seen that no law can be true except in an approximate sense. The work on sanitary engineering by B. Latham gives a table of capacity for sewer pipe which is claimed to have been tested by experiment. This table doubtless gives results somewhat too great for drain tile as usually laid, for sewer pipes are provided usually with socket joints and laid with more care than drain tile. I consider this table more likely to agree with the actual result found in practice than any derived purely from calculation, and have used it as a basis in working up a table of areas that can be drained with a given sized tile. The discharge is a function of the diameter, head, and length. For iron pipe Trautwine gives the discharge in cubic feet per second as

$$37.6\sqrt{\frac{\text{5th power of diameter in feet} \times \text{head in feet.}}{\text{Length in feet} + 84 \text{ diameters in feet.}}}$$

For drainage pipes the coefficients must differ very much from the above and probably must be more complicated. Another element of uncertainty arises from the fact that when drains are working to their full capacity water is admitted at each joint. Aside from the capacity of the tile are other considerations, some of which may be equally complex. The first is in regard to the amount of water that must be taken off from a given area in order to render it arable. The source of this water is from springs and direct rainfalls. It is necessary to so proportion the drains that the excess of water will be taken off before it has time to injure the vegetation. If all these considerations were perfectly known we should still have to deal with an element of uncertainty and doubt, and that is the power of the soil to retain water and the consequent time that must elapse before the water will reach the drains. It is evident that this time will be less as the drains are increased in a given area, since the water will travel more rapidly in the drains than through the soil. I present the following data as the result of research in this direction, and also a table for proportioning tile to the area to be drained. These results from the nature of the case are approximate, but nevertheless are sufficiently exact for farm drainage and will give satisfactory results in practice.

THE RAINFALL.

By consulting the State Agricultural College meteorological reports for the five years of '72-3-4-5-6 we find that during these five years, in the months of March, April, May, June, July, August, September, October, and November, there have been a total number of 304 rainfalls, in nineteen of which more than one inch of water fell during twenty-four hours. In nine of these rainfalls more than one and one-half inches fell during twenty-four hours, and in four rainfalls the amount exceeded two inches in depth in twenty-four hours. Expressing this in the form of percentage, six and three-tenths per cent of the number of showers gave a rainfall exceeding one inch in depth, while but three per cent gave a rainfall exceeding one and one-half inches.

By a farther consultation of the meteorological records we learn that, although these large showers in which the rainfall exceeds one inch occur comparatively seldom (on the average only four times a year), yet they bring with them twenty-eight per cent of our total rainfall during that period, and consequently they must be fully provided for in any works for thorough drainage. The following table is compiled from the meteorological records kept at the college, and shows the comparative depth and number of showers from the months of March to December for five years. The last column shows the total percentage of rainfall in all the showers of a given depth. The last column but one shows the total percentage of the number of showers compared with the whole number. Although this table is not extended sufficiently far back to give very accurate results, it is thought (since one year's rainfall does not differ greatly from that of another year), to be sufficiently reliable to produce data for any ordinary case of farm drainage in this portion of the United States. In cases where greater accuracy is needed it will probably be best to conduct a series of independent observations for a longer time.

TABLE OF SHOWERS FROM MARCH TO DECEMBER.

Depth of Rainfall in Inches.	Number of Showers.						Percentage of Total.	
	1872.	1873.	1874.	1875.	1876.	Total.	Number of Showers.	Amount of Rainfall.
.00 to .25....	19	40	28	35	43	165	54.2	17
.25 to .50....	20	14	3	9		67	22.0	21
.50 to .75....	6	8	6	10	5	35	11.5	21
.75 to 1.00....	2	6	5	2	3	18	06.0	13
1.00 to 1.25....	....	....		....	2	2	00.7	2
1.25 to 1.50....	3	2		....	3	8	02.6	9
1.50 to 1.75....	1	....		1		3	01.0	4
1.75 to 2.00....	....	1		1		2	00.7	3
2.00 to 2.25....	....	....		....		....	....	....
2.25 to 2.50....	....	1		....		1	00.3	2
2.50 to 2.75....	1	....		....		1	00.3	2
2.75 to 3.00....	....	....		....		....	....	....
3.00 to 3.25....	....	....		1	1	2	00.7	6
Totals.....	....	....		....		304	100.00	100

DISCHARGE OF DRAINS COMPARED WITH THE RAINFALL.

To ascertain this law Mr. J. Bailey Denton, of England, in the years 1856-7, caused observations of rainfall and discharge from drains to be taken during the months of October, November, December, January, February, March, April, and May. The area experimented upon consisted of two kinds of soil: first, soil of a mixed nature, consisting of clay, gravel, and sand, and second, a very stiff clay considered hard and almost impenetrable. The mixed soil was drained by occasional and wide parallel drains sufficient to discharge the rainfall and deep enough to relieve the pressure of subterranean water. The clay soil was drained uniformly by a parallel system of drains four feet deep and twenty-five to twenty-seven feet apart. The total cost of draining the 800 acres included in the area experimented on was 3,357*l.* 10*s.* or $16,787. The discharge from the open soils was more regular than that from the clays, probably because of the greater distance apart of the drains.

The rainfall per acre was 227,240 gallons and the discharge per acre on the mixed soil was 160,920 gallons, or about seventy-one per cent of the rainfall; on the clay soil it was 59,936 gallons, or about twenty-one per cent of the rainfall. The reason why clay discharges less than loam is doubtless found in the fact that it has greater power of retaining water by capillary attraction. Thus Professor Schübler, of Tubingen, found that 100 pounds of dry soil would retain the following amount of water that would not flow off:

Sand	25 pounds.
Loamy soil	40 "
Clay Loam	50 "
Pure clay	70 "

Observations conducted by Mr. John Dickinson, of England, for eight years, gave the following mean values of the discharge as compared with the rainfall: October to March, seventy-five and five-tenths per cent; April to September, seven and one-tenth per cent; average forty-two and four-tenths per cent. Mr. Tracy, in 1849, made some experiments in regard to the drainage of certain valleys near Boston, and concluded that the discharge varied from forty-four to forty-five per cent of the rainfall.

COMPUTATION OF TABLE FOR DRAINAGE.

The amount of discharge as compared with the rainfall depends upon so many conditions that it cannot be accurately stated, but probably will seldom or never exceed fifty per cent of the rainfall during the next twenty-four hours, under any conditions. In order to produce thorough drainage (in which surface water shall not be found longer than six hours more than once a year on the average), it is necessary to assume that the capacity of the drains shall be sufficient to carry off during twenty-four hours one-half the water that fell the previous twenty-four hours. The probability of the rainfall in any day exceeding one inch is so slight that we shall be safe in assuming the greatest ordinary rainfall to be one inch in twenty-four hours, and the necessary carrying capacity of the drains one-half inch for the same time. One inch of rainfall produces 3,630 cubic feet per acre, consequently our drains, to produce under all conditions thorough drainage, should be able to convey 1,815 cubic feet of water for each acre drained.

For ordinary farm drainage where the drains are simply to run under the low places on the surface of the fields, the water will be longer in reaching the drains, and consequently the acres drained

by a given sized tile may be increased with perfectly satisfactory results. Again, if flooding is of little moment for a few days at a time, the area may be correspondingly increased. I would recommend that the areas in the following table be doubled for ordinary farm drainage, but they must be changed with caution if thorough drainage, such as a gardener would need, is desired.

TABLE FOR SIZE OF TILE.

Rate of Inclination.	Acres Drained (Thorough Drainage).						
	2-inch Tile.	3-inch Tile.	4-inch Tile.	6-inch Tile.	8-inch Pipe.	10-inch Pipe.	12-inch Pipe.
1 foot in 20	6.7	18.6	26.8	74.4	150.0	270.0	426.0
1 foot in 30	5.5	15.1	21.8	60.4	128.0	220.8	346.0
1 foot in 40	4.7	12.9	18.6	51.6	108.8	189.6	298.4
1 foot in 50	4.3	11.9	17.0	47.7	98.0	170.4	269.0
1 foot in 60	3.9	10.9	15.6	43.4	90.0	156.0	246.0
1 foot in 70	3.6	10.0	14.5	39.9	83.0	144.4	228.1
1 foot in 80	3.4	9.3	13.4	37.2	77.0	135.0	213.0
1 foot in 90	3.2	8.8	12.6	35.0	72.5	127.0	200.5
1 foot in 100	3.0	8.3	11.9	33.1	69.2	120.6	190.5
1 foot in 150	2.4	6.7	9.5	26.6	56.0	97.3	154.4
1 foot in 200	2 1	5.7	8.2	22 8	48.0	83.9	132.5
1 foot in 250	1.9	5.1	7.5	20.4	42.4	74.4	117.0
1 foot in 300	1.7	4.6	6.9	18.4	38.2	65.5	107.0
1 foot in 400	1.5	4.1	5.9	16.5	32.6	60 3	90.7
1 foot in 500	1.3	3.7	5.2	14.8	30.1	54.0	81.6
1 foot in 600	1.2	3.3	4.7	13.3	28.0	48.6	74.0
1 foot in 800	1.0	2.9	4.1	11.4	24.0	41.9	65.0
1 foot in 1,000	0.9	2.6	3.7	10.2	21.2	37.2	56.0
1 foot in 1,500	0.8	2.1	3.0	8.5	16.8	30.8	47.0
1 foot in 2,000	0.7	1.9	2.9	7.4	15.0	27.0	40.8

To afford a simple rule for those who wish to construct drains simply through the low places of a farm, and who do not possess means of ascertaining the fall, the following will probably be sufficiently accurate: On the average the fall usually secured is about one in 200, and for ordinary farm drainage, doubling the results given in the table we find, that a drain of two-inch tile will drain four acres; three-inch tile will drain eleven and one-half acres; four-inch tile will drain sixteen and one-half acres; six-inch tile will drain forty-five and six-tenths acres; eight-inch tile will drain ninety-six acres, which rule does not differ essentially from the one given by Waring in his work on Farm Drainage. The above rule is for casual, not thorough drainage.

A rule for proportioning tile to area, said to be in common use among drainage engineers in Ohio, is that the number of acres drained is equal to the square of the diameter of the tile in inches; thus, two-inch tile for four acres, four-inch tile sixteen acres, eight-inch tile sixty-four acres. This rule does not agree very closely with the table but corresponds to a fall varying from one in sixty to one in 150.

FLOW OF WATER IN OPEN DITCHES.

The approximate formula obtained by Darcy and Bazin from numerous experiments is

$$Q=A\ V=C\ A\ \sqrt{M\ I}$$

in which Q=cubic feet discharged per second, V=velocity, A=area of cross section, I=sine of inclination, M=hydraulic mean depth, equal to area divided by wet perimeter, C=constant determined by experiment. The value of C for a very rough channel or canal in earth is given by Prof. Greenhill in Vol. XII Enc. Brit. as follows:

M	C
.25	.26
.50	.36
.75	.42
1.00	.48
1.50	.56
2.00	.62

The following table, applying to a drain one foot wide on bottom, and with sides sloping at an angle of forty-five degrees, has been computed from the above formula. The capacity of the drain is expressed in acres on the hypothesis that the drain should be capable of removing one inch of water or 3,630 cubic feet from each acre in twenty-four hours.

TABLE FOR CAPACITY OF OPEN DRAIN.

Width of bottom one foot; inclination of sides forty-five degrees, or one to one; drain full of water.

Inclination Expressed in Feet.	Capacity in Acres.				
	Depth 1 foot.	Depth 2 feet.	Depth 3 feet.	Depth 4 feet.	Remarks.
1 in 10	949	2,555	6,870	14,268	One acre is
1 in 25	447	1,204	3,239	6,726	considered the
1 in 50	314	846	2,290	4,725	equivalent of
1 in 100	224	603	1,622	3,365	3,630 cubic feet
1 in 150	204	542	1,458	3,027	each day of 24
1 in 200	157	424	1,134	2,356	hours.
1 in 250	142	382	1,027	2,132	
1 in 300	129	347	932	1,935	
1 in 400	108	289	779	1,619	
1 in 500	99	266	740	1,487	
1 in 1,000	70	189	507	1,053	
1 in 1,500	66	158	424	882	
1 in 2,000	51	140	367	763	
1 in 3,000	39	104	279	579	
1 in 4,000	32	87	234	487	
1 in 5,000	27	73	197	408	

The capacity of drains of the same depth, but having widths and cross sections differing from the areas tabulated, will be given approximately by considering that the capacity increases in the same ratio as the area. Thus to ascertain the capacity of a drain three feet wide on the bottom and four feet deep, with slope of sides

forty-five degrees:—the area of cross section would be twenty-eight square feet; the area of the cross section of the tabulated form four feet deep is twenty square feet; the capacity would be the corresponding tabulated number multiplied by 28–20. The result would be more accurate if it even increased somewhat more, as the the effect of friction is less as the breadth is increased for a given depth. The following factors should be introduced in the above results if a closer approximation is required:

TABLE OF FACTORS.

Depth.	Bottom width ½ foot.	Bottom width 1 foot.	Bottom width 1½ feet.	Bottom width 2 feet.	Bottom width 3 feet.	Bottom width 4 feet.	Bottom width 5 feet.	Bottom width 6 feet.
1	.91	1.00	1.09	1.15	1.21	1.25	1.26	1.28
2	.86	1.00	1.07	1.12	1.18	1.21	1.22	1.23
3	.83	1.00	1.05	1.09	1.13	1.15	1.15	1.16
4	.81	1.00	1.03	1.06	1.08	1.09	1.09	1.09

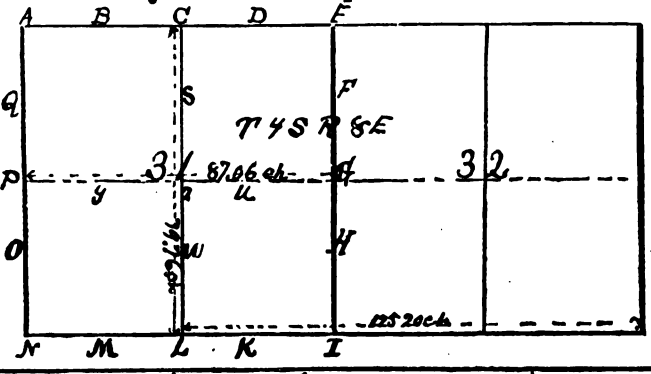
CONSTRUCTION OF UNDER-DRAINS.

The only point that is worthy of consideration is the method employed to secure the laying of the tiles on the grade line. For this purpose we stretch a cord or wire six, seven, or eight feet above the required grade, as the case may be. The cord or wire is set from the grade stakes by inverting the measuring rod on the grade peg and measuring from the top end a distance equal to the cut at the grade peg. The cord is supported each fifty or 100 feet by two slats each about seven feet long and free to move about a bolt passing through them about one foot from the upper end. These we term shears. The cord or wire is prevented from slipping by a couple of turns and is tied to a stake driven eight or ten feet from the shears. The shears possess this advantage over stakes with a cross bar nailed to them, that they are portable and can be put up very rapidly. They are, however, easily knocked out of place, and in drains where progress is very slow it is preferable to drive a stake each side of the drain and to this nail a cross-bar, care being taken that the cross-bar be level. Slack may be taken out of the cord or wire by the use of intermediate shears or by stakes driven by the side of the drain on which is a movable arm. By measuring from this cord or wire after it is set properly, the bottom of the ditch may be brought exactly to the grade. In laying the tile every joint should be tested by measuring from this line. The bottom of the ditch should be the full length of the measuring rod beneath the cord. The distance from the top of the tile to the cord can be indicated by a notch or arm on the measuring rod.

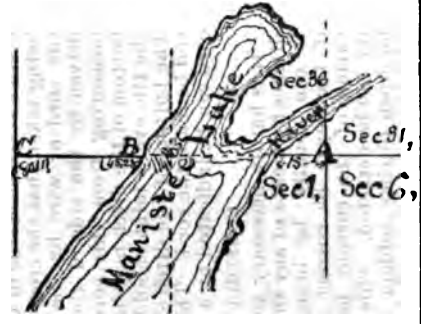
CONSTRUCTION OF OPEN DITCHES.

It is hardly necessary to test the grade of the bottom of open ditches by means of any such appliances as we have just described. It can usually be brought to a true grade by ascertaining if the depth be correct at each station stake; then by observation of the current between these two points any irregularity can be detected. This method is almost invariably practicable, for open ditches seldom fail to contain water. That the ditch may be permanent the sides should have a slope of two or three horizontal to one rise. In order to save first expense of construction, however, they are usually cut with a slope of one to one; the result is that they are soon choked up and need periodic cleaning.

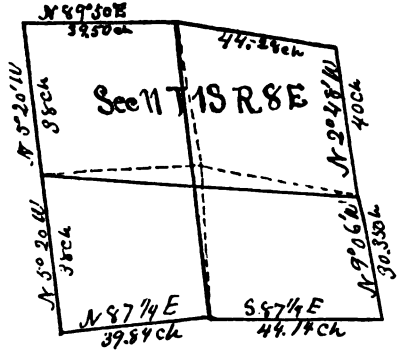
Question No 2,



Question No 11



Question No 1,



Questions
arising in
Actual Practice

PRACTICAL QUESTIONS.

ARRANGED AND ANSWERED BY J. H. LEAVENWORTH, OF SAGINAW.

GENTLEMEN:—Your executive committee has conferred on me the honor of answering the various questions which have arisen in the practice of the members of the association throughout the State during the past year. I have attempted to do so to the best of my ability, giving my reasons for the decisions which I have given.

DETROIT, MICH., *September, 1881.*

Question No. 1,—How should the center quarter-post of this section be established? (See Fig. 1.)

A. H. WILMARTH, *Surveyor.*

Answer,—The Surveyor General has reported that the boundary lines of this section were right lines; that the east and west boundary lines were run due north, and the distances from each quarter-post to the adjacent section corner were exactly forty chains, excepting on the north boundary, where they were 40.02 each; and the government sold the land according to that report and so specified in the deed. Consequently in subdividing the section we must assume that report to be according to the facts and locate the center at the intersection of two right lines between the quarter-posts north and south, and east and west. (Note,—By resolution the association concurred in the answer to question No. 1.)

DETROIT, MICH., *September, 1881.*

Question No. 2,—Section 31, T. 4 S., R. 8 E., Wayne county, Mich. The distance from P to G=87.06 chains; the distance from L to C =79.76 chains.

The whole distance from L or S quarter-post to the corner of sections 32 and 33 (that being the first visible corner), I find to be 125.20 chains. The corner of sections 31 and 32 being entirely lost how ought it to be established (at I)? Also how should the center quarter-post be located? A tangent from P to G would place it 24 links north of a point equidistant from L to C, making the south half-mile 40.13 and the north half-mile 39.63 chains. (See Fig. 2.)

Question,—Should the excess found between L and corner of sections 32 and 33 be equally divided in the three quarter-sections, or should the corner at I be placed at 40 chains from L, or should the line from E be produced through G to I, etc.?

Most respectfully submitted, A. H. WILMARTH, *Surveyor.*

Answer,—The field notes show that each township boundary line was established on a due north and south or east and west line (as the case may be), and a corner set at each 40 chains (except the

last half-mile of each line), and consequently at equal distances apart, being alternately section and quarter-section corners. The interior section lines were afterwards located from the section corners so established. If one or more corners on the township boundary are lost they should be re-established at proportional distances and in a right line between the nearest known corners on the same line. In this case the southeast corner of section 31 should be re-established at one-third the distance from the south quarter-post of section 31 to the corner of sections 32 and 33. The center of section 31 should be located at the intersection of a right line from L to C with another from P to G, for reasons given in answer to question No. 1. (The society concurred in the above.)

GAYLORD, MICH., *October 24, 1881.*

To the Executive Committee of the Michigan Association of Surveyors and Civil Engineers:

GENTLEMEN,—I wish to suggest a question or two for discussion at our next annual meeting in January.

No. 3,—Suppose the course of line between sections 19 and 30 of any township is N. 88° 30′ W., and the course of line between sections 30 and 31 is N. 89° W., and suppose that no quarter-post was ever set on the east side of section 30 in consequence of meandered lake in 29 and 30. Now it is proposed or required to run the east and west quarter-line. How shall the line be run?

No. 4,—Again, A owns the N. E. quarter of section 1 (any township); the south half contains 80 acres, the north half contains 85 acres. A. sells the quarter-section in parcels as follows: B. buys the S. E. quarter of the N. E. quarter of section 1, etc., the same being 40 acres more or less. C. buys the N. E. quarter of the N. E. quarter of section, etc., the same being 40 acres more or less, and so on. Each quarter of the quarter-section is sold and described as containing 40 acres more or less, and nothing said in the deeds about the quarter-section being fractional. How shall we divide? * * * *

Most truly yours, JOHN M. SANBORN.

No. 3. Answer,—The east and west quarter-line should be run from the quarter-post on the west boundary of the section, on a bearing which would intersect the east boundary at a point equidistant between the northeast corner and the southeast corner of section 30, that being the point at which the quarter-post should be located if no lake were there. If the quarter-post on the west boundary of the section is equidistant from the section corners this line would be N. 88° 45′ W., or an intermediate bearing between the two section lines, but not otnerwise.

No. 4. Answer,—It is evident from the description of the several deeds that it was the intention of A. to sell all of the quarter-section to the four parties, and it is a self-evident truth that where each of four persons buys one fourth of anything, nothing being said about either portion being fractional, each should have an equal quantity. Therefore the quarter-section should be subdivided the same as an interior quarter-section, by bisecting each of the four boundary lines of the quarter-section and connecting the corners so established by right lines north and south and east and west.

Referred to a committee consisting of Prof. J. B. Davis, Burton Kent, and J. H. Leavenworth, who reported as follows:

The descriptions are, in the opinion of the committee, inadequate. We do not feel qualified to say what the method of division should be.

Jan. 11, 1882.

J. B. DAVIS,
BURTON KENT,
J. H. LEAVENWORTH,
Committee.

Report adopted.

COLON, ST. JOSEPH CO., MICH., *Nov. 3, 1881.*

J. E. Sherman:

DEAR SIR,—I have the following case in practice which I would like to have discussed at the next meeting of our society, viz.:

No. 5,—The line in question is the north boundary of the S. half of the N. E. quarter of section 4, T. 7 S., R. 9 W. The government notes are as follows: North between sections 3 and 4, 40.00 chains, set quarter-section corner; 76.17 chains intersect N. boundary of township. Also north between sections 4 and 5, 40.00, quarter-section corner in lake; 42.50, set meander corner on margin of lake, 76.78 intersect N. boundary of township.

By my chain the distances are as follows: North from the quarter-section corner between sections 3 and 4, 20.00 chains, set set Temp. one-eighth-section corner; 35.025 chains the corner to sections 3 and 4 on N. boundary of township. Correct Temp. one-eighth-section corner 65 and 5-7 links south, and set a stake for corner.

From the meander corner on north bank of lake and the line between sections 4 and 5, I ran north 17.50 chains, set Temp. one-eighth-section corner; 34.28 chains, intersect township line at corner to sections 4 and 5.

It will be seen that a deficiency of 1.145 chains exists on the east line, and the west line measures exactly what the original notes called for. I will say here that all the original corners were completely identified. I now produced a true line from the one-eighth-section corner on the east boundary of the section to the one-eighth section corner on the west boundary of the section for the north boundary of the S. half of the N. E. quarter of section I would like the opinion of the association on the case, whether I took the proper course to produce the desired boundary line.

Yours truly, O. H. TODD.

No. 5. Answer,—If the distance from the southwest corner of section 4 to the meander post is exactly 42.50 chains, and the north boundary of the section is a right line, then the subdivision line of the north half of the section will be a right line, but not otherwise. In all cases the subdivision corner of a half section on the quarter line should be set at a proportional distance between the center of the section and the adjacent quarter-post; in this case in the proportion of 20.00 to 16.30½, and in case of a full half-section it should be divided equally, because if a quarter-section overruns or falls short by reason of the adjacent quarter-post being out of line with the section corners, if the line were a right line from one section line to the other the person buying the half (or fractional half) of the quarter-section lying on the section line would lose or gain the entire amount of the overplus or deficit. The person buying the half lying on the quarter line is just as much (and no more) entitled to his 80 acres as the other person is to whatever his deed calls for, and is entitled to his share of the loss or gain. (Answer adopted.)

WEST BAY CITY, *November 22, 1881.*

W. Donovan, Lansing, Mich., Acting Secretary:

SIR,—Your circular of 10th inst, to hand and I would like to submit the following to the association, if considered as a question of interest:

No. 6,—Are lines subdividing a quarter-section right lines extending through the section, or are they controlled by points equidistant from the corners on the boundary of the particular quarter section? Yours truly,

H. C. THOMPSON.

No. 6,—This question is answered in answer to question No. 5 (Answer adopted.)

COHOCTON, LIVINGSTON CO., MICH.

No. 7,—Should section lines running north and south be run in a direct line between known existing section corners in order to locate or establish missing or lost original section corners on interior sections?

No. 8,—Should the quarter-posts on township lines on the north and west not located or established by government surveyors be established by actual measurement equidistant between the section corners of the section to which they belong, or by measurement from the quarter-posts established when the township lines were run by the government surveyor?

ISAAC TELLER, *Surveyor.*

No. 7. Answer,—Where an interior section or quarter-section corner is lost it should be re-established at a proportional distance and in a right line between the nearest known corners (whether section, quarter-section, or meander corners). The field notes show that all north and south lines are run due north, and are consequently right lines, and east and west lines generally vary more or less from due east and west in consequence of imperfect measurements from the south boundary of the township, which is supposed to run due west. I agree with Judge Cooley that no corner should be considered lost as long as there is any evidence of where it originally stood. Frequently it is impossible to locate it exactly where it originally stood, but some circumstantial evidence shows that it stood within certain bounds, while considering it lost and re-establishing it by measurement would take it beyond those bounds. It should be re-established as nearly in its original position as possible without measurement. (Adopted.)

No. 8. Answer,—It frequently happens that the government surveyors in running township lines do not set their quarter-posts equidistant between their section corners, and sometimes the distance between the corners of sections in the two townships that should correspond, is more or less than it is represented. In either case the person buying the half-section on either side of the quarter line where no quarter-post was set is entitled to one-half the loss or gain caused by that mistake. Therefore the quarter-post should be established by actual measurement between the corners of the section but in line between the quarter-post as set by the government surveyors and the section corner. (Adopted.)

MANISTEE, *Dec. 13, 1881.*

No. 11,—Required to establish the quarter-post in lake, there being 38 links overplus from A to B. (See Fig. 11.)

M. S. COOK.

Answer,—We must in all cases assume that the distance between two points on a section line is what it is represented to be in the field notes of that line, and if by our chain we find a different distance, we must assume for the time being that our chain is enough too short or too long as the case may be, to make the difference. In other words, divide the overplus or deficit *pro rata* between the different parts of the line into which it is to be divided. In this case divide the 38 links *pro rata* between the 40.00 chains and the 5.28 chains. (Adopted.)

SUBDIVISION OF SECTIONS.

Isaac Teller kindly furnishes the following letter from the land office for publication. Its recent date makes it especially valuable. Mr. Teller calls attention to the exception herein stated to the rule given by Hawes, viz.: All lines subdividing a section must be straight lines running through the section from the corner in one boundary to the corresponding corner in the opposite boundary.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C., February 11, 1882.

Isaac Teller, Esq., Webberville, Ingham County, Michigan:

SIR,—I am in receipt of your letter of the 5th instant requesting information in regard to the proper method of locating the quarter-quarter corners north of the legal centers of the northern tier of sections in a township when the present measurement of the east and west boundaries of the section differs from the original measurement.

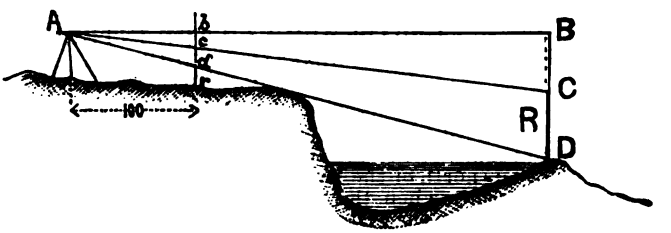
In reply I have to state that the length of the quarter line from the south quarter corner to the township line is to be considered as the mean of the east and west boundaries of the section as given in the field notes, and where the present measurement of the section lines differs from the original measurement the rule of proportionate measurement applies to the quarter line as well as to the section lines in the establishment of quarter-quarter corners on the half-mile closing on the township boundary. See enclosed circular dated November 1, 1879.

The mean width of the north half of the section in the case stated by you is 40.18 chains, while by your chaining it is 42.42 chains (calling the distance to the east and west quarter line 40.00 chains), therefore the proportion will be as 40.18 : 42.42 :: 20.00 : 21.11 chains, the distance north of the center of the section at which by your chaining the quarter-quarter corner should be located.

Very respectfully,
N. C. McFARLAND, *Commissioner.*

HORIZONTAL AND VERTICAL DISTANCES WITHOUT THE USE OF A VERTICAL ARC OR STADIA WIRES.

BY H. C. PEARSONS.



Example,—Required the horizontal distance, A B, having a level or transit, with rods and tapes for tools.

Take D C, a known distance on the rod R. Introduce an auxiliary rod, r, between A and B, and at a known distance from A, say 100 feet, point the telescope successively on C and D, noting the intercept c d, on the auxiliary rod r, then:

D C÷c d=A B in terms of A b, for c d is the analogue of C D, which equals length of R, thus,

Supposing R=12 feet, c d=.845 feet, and A b=100 feet, then,

A B=(12÷.845)×100=1,420 feet.

If it is also desired to find the vertical height B D, note the intercept on the auxiliary rod between the lower target and the level line, and multiply it into the ratio of R to c d, thus,

Supposing b d is found to be 2.126 feet, then as R÷c d=14.2 feet we have

D B=14.2 feet×2.126=30.189 feet.

For difference of level this would be subject to correction for "curvature" and refraction, in this case .045, so that 30.189—.045=30.144 feet, the difference of level required. (See Engineering News for January 14, 1882, page 14.)

This method has the advantage of greater precision than can be attained by the use of the small vertical arc on our field instruments or with stadia wires.

VARIATION OR DECLINATION OF THE NEEDLE.

AS REPORTED BY VARIOUS OBSERVERS.

VARIATION.	Annual Change.	County.	Location.	Authority.
0° 13′ W. in '80	3′	Wayne.	Detroit.	U. S. lake survey.
0° 45′ E. in '78	4.94′	Washtenaw.	Ypsilanti.	C. S. Woodward.
1° 12′ E. in '51	4.94′	Washtenaw.	Ypsilanti.	C. S. Woodward.
2° 14′ E. in '74	6¾′	Washtenaw.	Lyndon.	J. K. Yocum.
1° 20′ E. in '82	6¾′	Washtenaw.	Lyndon.	J. K. Yocum.
2° 15′ E. in '81	.....	Livingston.	T. 1 N., R. 3 E.	M. W. Bullock.
1° 50′ E. in '81	.....	Livingston.	T. 1 N., R. 5 E.	M. W. Bullock.
1° 37′ E. in '81	.....	Livingston.	Brighton.	I. O. Walker.
2° 27′ E. in '81	.....	Eaton.	Dimondale.	M. W. Bailey.
1°+ E. in '82	.....	Ingham.	Winfield.	Lee S. Cobb.
1° 40′ E. in '76	.....	Ingham.	Lansing.	H.D.Bartholomew.
.....	4½′	Saginaw.	St. Charles.	J.H.Leavenworth.
2° W. in '82	.....	Gratiot.	St. Louis.	S. S. Hastings.
2° 13′ E. in '81	3¼′	St. Joseph.	Colon.	O. H. Todd.
3° 10′ E. in '81	.....	Berrien.	Avery.	Thomas Love.
2° 30′ E. in '82	6½′	Van Buren.	South Haven.	A. T. Pierce.
2° 23′ E. in '82	6⅝′	Van Buren.	Lawton.	C. D. Lawton.
2° 50′ E. in '82	.....	Ottawa.	Ferrysburg.	H. C. Pearsons.
1° 5′ E. in '81	.....	Kent.	Grand Rapids.	H. H. Collar.
1° 40′ E. in '82	.....	Montcalm.	Greenville.	H. M. Caukin.
Less than 30′ in '82	.....	Wexford.	Cadillac.	A. J. Teed.
3° 10′ E. in '82	.....	Manistee.	Manistee.	M. S. Cook.
1° 20′ E. in '82	.....	G. Traverse.	Traverse City.	S. C. Hodgman.
4° 42′ E. in '80	.....	Ontonagon.	Ontonagon.	G. P. Cumings.
3° 25′ E.	.....	Marquette.	Marquette.	C. D. Lawton.
0° 0′ in '82	.....	Oakland.	Four Towns.	Sloan Cooley.
0° 56′ W. in '82	.....	.....	SaultSte.Marie	Geo. H. Casleton.
2° 15′ E. in '82	.....	Cass.	Vandalia.	Amos Smith.

SOCIETY'S FUND ACCOUNT.

JANUARY 14, 1881, TO JANUARY 10, 1882.

Cash on hand Jan. 14, 1881	$139 33
Interest on bank account	1 28
Received from advertising	16 00
Received from members (dues)	49 00
From sale of reports	14 56
	$220 17

PAYMENTS FOR SAME PERIOD.

For Postage	$22 97	
For Printing	85 84	
For manual committee	35 93	
For executive committee	23 35	
Express	30	
		$168 39
Balance on hand		$51 78

REPORT OF AUDITOR.

I find the above statement of the society's funds to be correct,
H. D. BARTHOLOMEW, *Auditor.*

AMOUNTS APPROPRIATED BY SOCIETY BUT UNPAID.

To committee on manual	$69 07
To T. E. Sherman	30 00
	$94 07

Remark:—The above statement does not include the dues for 1882.

AN OPEN LETTER.

Tribune Building, New York, Jan. 21st, 1882.

To the Surveyors of Michigan,

GENTLEMEN:—Allow me to congratulate you on the very commendable progress you are making toward a higher professional standard. You are under good leadership, and with the many very able men in your ranks you are bound to succeed if you persevere. INTELLIGENT CO-OPERATION is what you must encourage, first, last, and always. The lower the intelligence the smaller the pay, as a usual thing. If you can create a body of specially educated men to undertake the duties of land-surveying, you will in time create an influence in their favor that will command attention from your law-makers and the general public, and so lead to a higher remuneration; which is, after all, what you are striving for.

Allow me also to remind you that ENGINEERING NEWS is the only journal ever published that has manifested the slightest interest in land surveyors and their work. For ten years we devoted our paper almost exclusively to them, and at a price within reach of the most impecunious; but we did not realize our postage account. We have however published more information of value to surveyors during the past eight years, than all the other papers in the Union together; and if the surveyors would subscribe in sufficient numbers now to make it an object, we would give them a fair equivalent during each year in the shape of information of direct value to them. Every surveyor ought to be interested in civil engineering; and every surveyor and civil engineer should read at least ONE professional journal. The subscription price of ENGINEERING NEWS is $4.00; but if a number of subscribers will club together they can get it for $3.00, which is less than ONE CENT PER DIEM of outlay.

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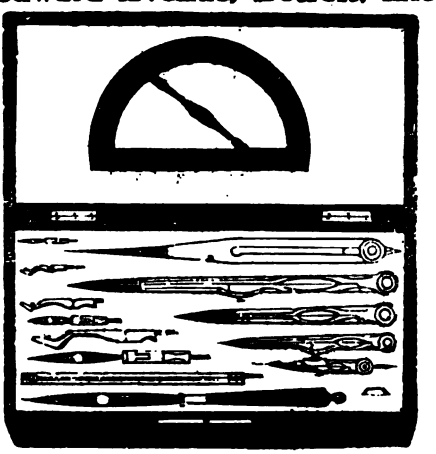

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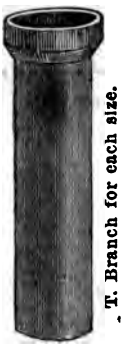

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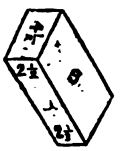

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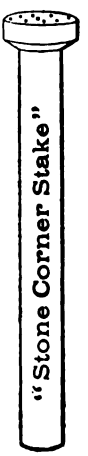

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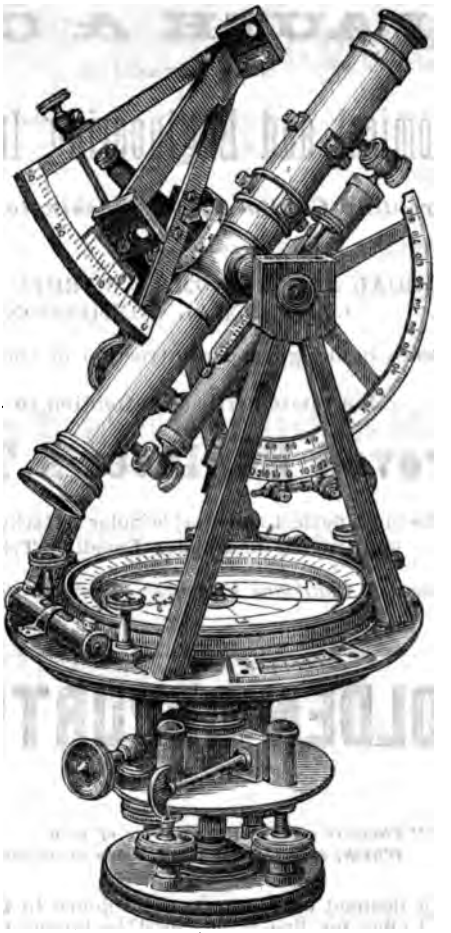

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SMITH, RICHARD.....Port Austin, Huron "
Surveyor; Real Estate and Abstracts of Title.

SNOVER, C. M. C.....Yankton, Dakota Ter.
Assistant to Surveyor General.

STAGE, M. B.....Clio, Genesee Co.
Surveyor.

STEELE, GEO. E.....Traverse City, Grand Traverse "
Surveyor; Real Estate, Insurance and Abstracts.

STRUDWICK, HENRY.....Bad Axe, Huron "
Surveyor and Civil Engineer.

TEED, AUGUSTUS J.....Cadillac, Wexford "
City Surveyor of Cadillac

TELLER, ISAAC.....Cohoctah, Livingstone "
Special Agent U. S. Land Office.

TERRY, H. E.....Maple Rapids, Clinton "
Civil Engineer; Principal of School.

THOMPSON, HENRY C.....West Bay City, Bay "
County Surveyor; City Recorder.

THORNTON, WM.....Grand Rapids, Kent "
Railroad Engineer.

TODD, O. H.....Nottawa, St. Joseph "
Surveyor; Lumber Dealer.

TREADWELL, E.....East Saginaw, Saginaw "
Surveyor and Civil Engineer.

VAN LIEW, E. S.....West Bay City, Bay "
City Engineer; Sec'y., Treas. and Supt. of Water-works.

VINCENT, WM.....Manistee, Manistee Co.
Surveyor.

WALKER, I. O.....Ann Arbor, Washtenaw "
Surveyor; Civil En'g, Student, University of Michigan.

WATKINS, JOHN J.....Lapeer, Lapeer "
City Surveyor of Lapeer.

WELLES, B. F.....Marshall, Calhoun "
Principal Ass't. Engineer, P. H. & N. W. R. R.

WHITE, THOMAS.....Alpena, Alpena "
Surveyor; Real Estate.

WILMARTH, A. H.....Sand Hill, Ingham "
County Surveyor.

WOODARD, C. S.....Rockland, Ontonagon "
Chief Engineer, O. & B. R. R. R.

YOCUM, J. K.....Chelsea, Washtenaw "
Surveyor and Civil Engineer.

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*MILLS, FRANK P.....Crystal Falls, Lake Superior "
Mining Engineer, Youngstown Iron Mining Co.

*SHŒDDE, R.....Manistee, Manistee "
Surveyor.

*Applications received too late for action.

HONORARY MEMBERS.

COFFINBERRY, W. L.....Grand Rapids, Kent Co.
MUNRO, JOHN F.....Detroit, Wayne Co.

MICHIGAN ASSOCIATION

OF

SURVEYORS AND CIVIL ENGINEERS.

THE CONSTITUTION.

PREAMBLE.

For the purpose of improving ourselves in the knowledge of our profession, and securing greater uniformity in our methods of practice, we, the undersigned civil engineers and surveyors, hereby associate ourselves together under the name of the Michigan Association of Surveyors and Civil Engineers, and adopt the following as our constitution and by-laws:

SEC. 1.—OF MEMBERSHIP.

Any surveyor or civil engineer in good standing in the profession may become a member of this society by signing the constitution and paying two dollars into the treasury: *Provided*, That all applications for membership shall be endorsed by at least one member of the society, and by the executive committee; and further, that each applicant shall receive a three-fourths majority vote of the members present at any regular meeting, not less than a quorum being present.

SEC. 2.—OF OFFICERS.

The officers of this society shall be a president, a vice-president in each congressional district in this State, and a secretary, who shall also be the treasurer.

The treasurer shall give bonds in such sums as the society shall from time to time determine, and shall make a report of the finances of the society at each annual meeting.

SEC. 3.—DUTIES OF OFFICERS.

The duties of these officers shall be such as are performed by similar officers in other societies. They shall hold their offices for one year, and until their successors are elected and qualified.

SEC. 4.—OF ELECTIONS.

Elections of officers shall be by ballot, and shall be held on the last day of the regular meeting in January of each year.

SEC. 5.—OF AMENDMENTS.

This constitution may be amended at any regular meeting by a majority of two-thirds of the members present: *Provided*, That such amendment shall have been submitted in writing on the first day of said meeting and referred to a committee for consideration.

BY-LAWS.

SEC. 1. A quorum for the transaction of business shall consist of ten members.

SEC. 2. There shall be a regular meeting in each year, commencing on the second Tuesday of January at two o'clock P. M.*

SEC. 3. Special meetings may be held at any time on call of the Executive Committee.

SEC. 4. There shall be an annual due of one dollar, payable on the first day of the regular meeting; and no member of the society shall be entitled to vote, or to any of the rights, benefits or privileges of the society while in arrears for dues.

SEC. 5. There shall be an executive committee of five members, of which the president and secretary shall be members *ex officio*, who shall have general charge of the business transactions of the society. This committee shall be appointed by the president, and its members will hold their office for one year and until their successors are appointed.

Special committees will be appointed at any time when their services are demanded.

STANDING RESOLUTIONS.

MANUAL.

Resolved, That a committee of three be appointed to confer with the commissioner of the State land office in regard to compiling decision of the courts and adopting methods of establishing lines and corners in this State; also to bring the matter before the next legislature.

Resolved, That members of the society and others interested be and are hereby requested to furnish the chairman of the committee on manual with field notes, as taken in the field, of one or more sections they have subdivided; also diagram and full description of (the same) lines and corners as they appear of record, selecting such sections as will in their judgment assist the committee in their work, the object being to secure the committee a large number of representative cases.

Question of riparian rights was, by resolution, referred to the committee on manual.

The foregoing is the original. At the meeting in 1881 the following was added:

Resolved, That the committee on manual be enlarged to four members; that they proceed with the work as rapidly as possible, and that one hundred dollars be appropriated to defray their necessary expenses.—NOTE—Committee reduced to two by general consent in 1883.

Resolved, That the subject matter of the manual be confined to proprietary rights.

LOST CORNERS.

Resolved, That it is the sense of this convention that a lost corner in the terms of the instructions issuing from the U. S. Land Office for restoring such means a corner about the position of which there is no evidence nearer than the nearest monument of the original land survey; also that the instructions should not be applied to these cases until other sources of evidence are exhausted.

LANDMARKS—(ADOPTED IN 1881).

Preamble. In view of the rapid destruction of landmarks which is being carried on by destroying witness-trees and obliterating the

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*Date of next meeting to be fixed by the Executive Committee.

evidences of the United States survey, and in view of the expense and difficulty of restoring these corners when lost, the ill-feeling and litigation which follows their loss:

Resolved, That we recommend to the people of the State and to boards of supervisors that immediate steps be taken to preserve all the corners of the United States survey; and

Resolved, That in perpetuating these corners the best and most durable materials should be used for landmarks, and that they should be properly lettered and numbered for the corners they designate; and

Resolved, That as a matter of public economy we recommend that such work should be done, not by the person who will do it for the least money, but by the person who will be likely to do it the most thoroughly; and that all obtainable evidence in regard to the locations of these corners should be got together and thoroughly sifted by the surveyor before any such landmarks are placed.

MISCELLANEOUS—(ADOPTED IN 1883).

Resolved, That all members in arrears for two years dues, after havbeen duly notified by the Secretary, be dropped from the list of members.

Resolved, That a bond of $200 be required of the Treasurer, which shall be subject to the approval of and be deposited with the Executive Committee.

Resolved, That the price of Proceedings be twenty-five cents; that extra copies exceeding three be furnished to members at ten cents each; but that members be requested not to sell them to non-members for less than twenty-five cents.

Resolved, That the Association ask of all its members a statement of the data of all deep well-borings, including depth of their geologic strata, to be reported to the Secretary at least one month before our next regular meeting.

Resolved, That we continue the publication of the data in regard to variation of the magnetic needle.

Resolved, (adopted in 1882), That the Secretary be instructed to secure, by exchange, reports of Proceedings of similar associations in other States for the members of this Association.

THE EXECUTIVE COMMITTEE.

Resolved, That the executive committee be directed to meet at least 60 days prior to each annual meeting of this society. Said committee shall divide its work and designate one of its members to have charge of each subdivision so made, and of all correspondence relating thereto.

That members of this society, or of the profession, having questions of practice or topics which they wish discussed by the society, shall submit the same to the committee as early as possible during the year. All matters to come before the society the committee shall, so far as possible, prepare and present in convenient form for its action.

That said committee prepare and distribute a programme of the business so arranged.

That the necessary expenses of the committee for such meeting shall be paid by the treasurer of the society.

The committee will meet October 15, 1883. "Any practical questions" or other matter on which decisions are needed may be referred at any time to the President or Secretary.

FOURTH ANNUAL MEETING

OF THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

HELD AT LANSING, JANUARY 9–11, 1883.

SECRETARY'S REPORT OF THE PROCEEDINGS.

The association assembled Tuesday, January 9, in the Pioneer Room, at the State Capitol, and was called to order by the Secretary promptly at 2 P. M.

A telegram from President Greene was read, stating that, from failure of railroad connection, he would not be present until evening. Vice-president Francis Hodgman was then called to the chair and presided over the afternoon session; the President took the chair at the opening of the evening session.

The annual report of the Treasurer was received and referred to an auditing committee of two, J. J. Watkins and M. H. Bailey. (For Treasurer's Report see last page of Proceedings).

The chairman appointed, as a committee to examine and report upon the exhibit of Instruments, M. W. Bullock, S. N. Beden and Prof. J. B. Davis. The report of this committee was not completed in time to be submitted during the meeting, but is published in full in these Proceedings.

New Members.—Applications for membership, duly endorsed, acted on by the Executive Committee and recommended by them, were received by the Association at different times during the meeting, and, by a special vote in each case, the applicants were admitted to membership, as follows:

C. H. Cavis, Marquette.
J. C. Leonard, Union City.
H. I. Orwig, Big Rapids.
A. G. Fuller, Kalamazoo.
G. S. Pierson, Kalamazoo.
G. H. Carleton, Sault Ste Marie.
J. Ludington, Verona Mills.
Luther Hemingway, Sodus.
Kaison Freeman, Grand Rapids.
Wm. P. Innes, Grand Rapids.
T. W. Pettee, Montrose.
J. A. Graham, Calkinsville.
J. J. McVean, Ionia.
Prof. C. F. R. Bellows, Ypsilanti.
P. H. Dowling, Rome.
Q. A. Thomas, Oxford.
Jas. P Greene, Oxford.
Wm. Appleton, Lansing.
Sherman Olmstead, Midland.
Horace Jerome, Cass Bridge.
Walter S. Russel, Detroit.
A. R. Stowell, St. Clair.
Francis M. Priest, Bryan, O.

The resignation of Mr. Thos. Love as a member of the Committee on Manual, tendered on account of ill-health, was accepted.

Communications were read from A. J. Pierce, Aberdeen, Dakota, and Andrew Huggins at Corunna.

Order of Exercises.—The following programme exhibits the order of exercises at the several sessions, conforming very nearly with that arranged by the Executive Committee, and printed and mailed to each member previous to the meeting. Opportunity for discussion was offered after each paper, and such remarks as were taken down by the Secretary will be found following the respective papers.

PROGRAMME.

Tuesday, January 9.—2 *p. m.*

Association called to order. Reading of Minutes. Committee to examine Surveyors' Instruments appointed.

Legislative Needs of Surveyors.—George E. Steele, Grand Traverse.

The North Lansing Mill-Dam.—H. D. Bartholemew, Lansing.

Wooden Pavements.—H. G. Rothwell, East Saginaw.

7:30 *p. m.*

Address of President; Water as a Source of Engineering Difficulty. Chas. E. Greene, Ann Arbor.

Common Roads.—Burton Kent, Adrian.

Wednesday, January 10.—9 *a. m.*

Difficulties in City Surveying.—A. J. Teed, Cadillac.

Construction and Care of Water-works suitable for small Cities in Michigan.—Chas. B. Hyde, Jackson.

2 *p. m.*

Logging Railroads.—E. F. Guild, East Saginaw.

Questions in Practice.—I. H. Leavenworth, Saginaw City.

Manufacturers' Exhibit of Instruments.

7:30 *p. m.*

Questions in Practice, continued.

Necessary Instruments for Surveyors.—J. B. Davis, Ann Arbor.

Thursday 11.—9 *a. m.*

Reports of Committees.—Manual; Legislation.

Surveying for Railroads.—F. Hodgman, Climax.

2 *p. m.*

Construction and Operation of Narrow-Gauge Railroads.—A. L. Reed, Port Huron.

Projection of a Parallel of Latitude.—H. C. Pearsons, Ferrysburg.

7:30 *p. m.*

Traverse Surveying.—J. B. Davis, Ann Arbor.

Engineering of Town and County Drains.—S. N. Beden, Pine Run.

Suggestions of President.—The President prefaced his paper with some remarks and suggestions to the Association. He extended a general welcome and congratulations upon the large attendance, and referred to the benefits to be derived from these yearly meetings; the increase of cordiality in the greetings of those no longer strangers; the interchange of ideas; the fellow-sympathy and personal esteem carried through the year, gladdening the heart and leading us to look forward to each convention with most pleasant anticipations. He said that another opportunity was now afforded, to endeavor to obtain, should it seem wise, such legislation as appears to be needed by the profession, and that we ought to so profit by the experience of two years ago that our new bill would commend itself to the wisdom of our Legislators. He suggested the desirability of having the proceedings of the association printed in a handsomer form than that of last year. As the expense of publication is very little, this modification can be secured without burdening the treasury. As Judge Cooley's paper is out of print and still in demand, the President proposed that it should be reprinted this year; and, with this end in view, he had secured an additional note and some further references from Judge Cooley. He also stated that a change in the time of holding the annual meeting is desired by some of the members, and he recommended that other cities besides Lansing be considered as places of meeting. He pointed out the advantages of thus becoming acquainted with different towns and the objects of engineering interest to be found in their neighborhood; making ourselves better known as an organization throughout the State; and avoiding the crowd and discomfort attending a meeting at Lansing at this season. He closed his preliminary remarks with the recommendations that each paper, if possible, should, before the meeting, be put into the hands of some member interested in the subject, who could then prepare himself to lead in the discussion which ought to follow the reading, and bring out many points of interest and value.

Some of these suggestions were formally acted upon by the Association, as will be seen in these pages.

Time and Place of Meeting.—A motion, by Mr. Guild, to hold the next meeting at East Saginaw, was carried, an amendment,

offered by Mr. Skeels, to substitute Grand Rapids, having previously been negatived. On motion, the date of the next meeting was referred to the Executive Committee with power. From the remarks of members present the Secretary infers that the most acceptable time will be the last week in December or the first week in January.

Standing resolutions passed at this meeting will be found on p. 11.

REPORTS OF COMMITTEES.

The Committee on Library reported, through the Secretary, that one of its members, Prof. J. B. Davis, had prepared a list of books which had been submitted to the State Librarian, Mrs. Tenny. The librarian had given the list favorable consideration, and would probably purchase the books for the State Library, if she should be re-appointed this year.

The Committee on Manual reported progress and stated that they expect to have the work done before another meeting; that they have a large amount of material, embracing—History of the Rectangular System; History of original surveys in Michigan; Legal decisions covering all kinds of surveyors' practice, and on questions of boundary, title and occupancy of lands; and that they regret very much that Prof. R. C. Carpenter, from press of other work, and Mr. Thomas Love, from failing health, have felt obliged to resign their places as members of the committee.

A resolution in regard to the scope of the Manual will be found among the Standing Resolutions.

The Committee on Legislation advised an attempt at this session of the Legislature to have a law passed for the benefit of the public. The paper by George E. Steele, of Grand Traverse, chairman of this committee, and the discussion following will show the views of the members. The principal features of the bill introduced are as follows:

> To authorize the appointment, by the Governor, with the advice of the Senate, of Commissioned Surveyors, without limit as to number or qualifications. All surveys for permanent record to be made by these officers or by county surveyors. Commissioned surveyors, when entering upon duty, to give bonds to the people in the sum of $2,000. Record of surveys to be made by them, of a specified form and size, and such record to be deposited with the Register of Deeds of each county, and to be by him fastened in a book provided for that purpose.

The bill does not provide for the repeal of any existing statutes regarding the county surveyor.

MISCELLANEOUS.

Boundary between Ohio and Michigan.—The following resolution was adopted by the Association, and Messrs. Steele, Drew and Davis were appointed a committee to draw up a memorial to the Legislature.

> WHEREAS, This Association, at its session two years ago, adopted a memorial to the Legislature, calling attention to the condition of the State Line between Michigan and Ohio, which memorial was referred to the committee on State Affairs and received no further attention; and
>
> WHEREAS, The surveyors from the State of Ohio, now visiting this meeting, represent it to be of great importance that this line be immediately determined and perpetuated by proper authority; therefore
>
> *Resolved*, That we again memorialize the Honorable the Legislature of Michigan to at once provide for the survey of this line by competent authority, and to secure the proper concurrent action from the State of Ohio.

Exhibits.—The exhibit of Surveying Instruments was especially good and will be described in detail in the report of the committee already referred to.

The Jackson Fire Co. exhibited sewer pipes, drain tiles and a fire-clay corner mark. These articles attracted considerable attention, and members generally expressed themselves pleased with them.

Visitors.—Two surveyors from Ohio, Messrs. F. M. Priest and E. B. Opdyke, of Bryan, members of the Association of Surveyors of that State, were present throughout the meeting. They were formally introduced by the President, and, on motion of Mr. Steele, were given seats on the floor and invited to participate in the discussions.

The Association again had the pleasure of meeting Mr. L. E. Gurley, of Troy, N. Y., who was present at nearly all of the sessions. Mr. Gurley was invited, on the afternoon of the second day, to address the members, when he exhibited some of the more recent instruments and devices produced at his manufactory. He stated that his firm were desirous of having their instruments criticised, as in that way they would be prepared to perfect them.

Mr. T. N. Watson, from Young and Sons, Philadelphia, formerly of Burt and Watson, Detroit, arrived somewhat late from missing railroad connections, but availed himself of an invitation to explain the merits of the instruments manufactured by his firm.

Officers for 1883.—Messrs. Drew, Mark and Caukins were, on motion, appointed by the Chair a committee on Nomination of Officers, and at the last afternoon session reported a ticket for the consideration of the Association. On motion, the Secretary was directed to cast a ballot for the same, and, this vote having been taken, the officers whose names appear on the third page of this report were declared duly elected for the current year.

President-elect Davis was then escorted to the chair by Messrs. Appleton and Leavenworth, and, upon assuming his office, offered a few remarks, complimentary to his predecessor.

Vote of Thanks.—Before final adjournment a vote of thanks was passed—To the railroad companies for reduced rates and other courtesies; to those who had prepared papers for this meeting; and to the officers of the Association for their efficient work.

The Association then adjourned for one year. It was generally conceded that this was the largest and most satisfactory meeting that the Association has ever held; the attendance and interest were continued until its close.

Messrs. Hyde and Reed have been prevented, by press of business, from preparing their papers for publication.

ANNUAL REPORT OF TREASURER.

From Meeting of 1882 to Meeting of 1883.

RECEIPTS.

Cash on hand January 10, 1882	$ 51 78	
Dues received at Meeting of 1882	43 00	
Dues for 1882 paid since Meeting of 1882	27 00	
Fees of new members paid since Meeting of 1882	18 00	
Dues for 1883, paid before January 8, 1883	4 20	
From advertisers in Proceedings	100 00	
Sale of Proceedings	7 07	$251 05

PAYMENTS.

Printing Report (voucher No. 1)	$100 02	
Miscellaneous printing (vouchers No. 1, 2, 3 and 4)	38 90	
Engraving (vouchers No. 5 and 6)	14 04	
Expenses executive committee (vouchers No. 7, 8, and 9)	14 50	
Expenses manual committee (voucher No. 10)	4 00	
Postage for year (voucher No. 11)	20 86	
Stationery (vouchers No. 12 and 13)	6 73	$199 05
Cash on hand, January 9, 1883		$ 52 00

BILLS RECEIVABLE.

Note of H. Strudwick, Relief Fund	$ 25 00
Due for advertising	2 50

BILLS PAYABLE.

Appropriated to Committee on Manual, by vote of Association—balance $ 60 15

Mr. J. E. Sherman donates to the Association the sum of $30 voted at our second meeting for services as Secretary.

RELIEF FUND.

Cash on hand January 10, 1882		$ 62 90
Bought, per order of Association, one compass for J. Ludington	$ 30 00	
One steel tape, donated by M. W. Bailey, and sent to J. Ludington		
Draft and express on above articles	1 40	
Loaned H. Strudwick (see note)	25 00	
Drawing paper for H. Strudwick	2 00	58 40
Cash on hand January 10, 1883		$ 4 50

The auditing committee have examined the above accounts and the vouchers pertaining thereto and find them correct.

[SIGNED] John J. Watkins,
M. H. Bailey,
Committee.

Lansing, January 12, 1883.

LEGISLATIVE NEEDS OF SURVEYORS.

BY GEORGE E. STEELE, OF GRAND TRAVERSE.

If this paper is to be confined to the topic assigned by the Executive Committee we shall fear no charge of prolixity in its discussion. The legislative needs of surveyors themselves are very few; and considering the evident disposition of the Legislature to so regard them, we are reminded of the couplet:

"Man wants but little here below,"
And—————————he gets it.

For the last six years our honored law makers have had to stamp the foot on the irrepressible surveyors who were troubling them. There was presented to the last Legislature what this Association believes was, all things considered, a meritorious bill:—"A Bill to establish a Board of Commissioners of Surveys and to further provide for the public surveys." This bill, having passed the Senate, was adversely reported upon in the House by the Committee on Geological Survey.* If one-half of the labored report which this committee made was true, the bill should have been strangled long before it came to the Senate. But our present object is not to point out its merits or defects, and so we leave it with the Committee on Geological Survey—behind the scenes.

The next step as to necessary legislative action depends on one of two things. Either, first, the county surveyor's office should be retained with modifications, or second, it should be abolished.

In the proposition to retain the office of county surveyor we can see little advantage, save in a less abrupt change of the law, and in favor of those who think the county surveyor should be the custodian of the records. It is merely the acceptance of what we have because we have no better. Section 99, Compiled Laws, 1871, should be so amended that, if there is no county surveyor able to act, the survey may be made by any surveyor, in like manner and to the same effect as if such survey had been made by the surveyor of the county where the land is situated. Act 103, session 1881, requires the county surveyor to record any survey, provided such survey was made in accordance with the laws of this State! E pluribus unum! How we want some *Latin* to use! *The county surveyor must decide whether a survey is made in accordance with law!!* P. S.—This is to save the time of the courts. The same act declares that all surveys made by *county* surveyors in this state must be made in accordance with the following principles when applicable. How then are other surveyors to make their surveys

*See report third meeting Michigan Association, 1882.

if only county surveyors are to be governed by these principles which are laid down? By striking out the word county in the last Section the Act would be homogeneous.

To the second proposition we are already, in the previous reports of this Association, quite committed; and have yet to learn of any valid reason for the continuance of the office. It is true that, under the present law, the county surveyor has some duties and prerogatives which others have not. 1st. He may use the tax rolls to insure his pay. 2d. His certificate is presumptive evidence. 3d. He must make a survey required by order of any court. 4th. He must make record of his surveys. 5th. He is made custodian of copies of field notes. 6th. He is not liable for trespass. 7th. He can swear chairmen and marker. 8th. He must witness new bearing trees to original corners as old ones decay. 9th. He must make surveys according to certain principles.

There is not one thing here conferred upon the county surveyor which the law might not confer upon any surveyor, after providing a place for the records and field notes.

But it is the common, though erroneous, opinion that there is some official function belonging to the county surveyor. Justice Cooley, of our Supreme Court, has already instructed this Association that "no statute can confer upon a county surveyor the power to establish corners, and thereby bind the parties concerned," and again in his valuable paper he says, "and county surveyors no more than others can conclude parties by their surveys."

Had you ever thought what a *terrible* calamity would befall that county which should not have a qualified county surveyor? Let us draw near this suffering community! Farmer A wants his corner established, and he wants it bad. He goes to a surveyor of good reputation—the common kind we mean!—finds that he has a nice instrument, and a copy of the original field notes, all his own, and he engages him at a price. The surveyor after much search discovers the remains of the witness tree and stake, and perpetuates the corner in a substantial manner, making full notes of all his measurements and operations. But alas! for all his knowledge and accuracy! When Mr. A finds that the surveyor did not run on the Democratic-Greenback-Republican ticket last fall, it is all for nought. This is no overdrawn picture. How many times have you, brother surveyors, been asked if you were the county surveyor; and, when you replied to the contrary, have you not noticed the blank astonishment that pervaded that once radiant face?

How long will this law deceive the people by continuing an office in which men can make no better or more binding surveys than they could without the office? Why is it not just as necessary to elect one man in each county to dispense medicine by law? The people are left free to employ their doctors and masons and carpenters. They generally try to secure the best and most available ones they can get;

and, if poor work is the result, it would be no better if from an officer elect. If it is not thought best to require surveyors to pass an examination, then provide the simplest law possible.

The purview of every surveyor is to do the field work which may sometime be required in evidence by court and jury. Then that law which provides that this work shall be done in the best manner, and above all that a complete record of it shall be preserved, will be of most value. Such we should seek to secure. Its main features would be:

First. Any person (with a few restrictions and perhaps prohibitions) may make surveys.

Second. Surveys must be made according to a well understood plan.

Third. Surveys must be entered of record in the Record of Surveys in the office of the Register of Deeds of the County in which they were made.

The first and third divisions the law only can provide for. The *plan of surveys* may be marked out by law, or it may be arranged by the concurrent action of the surveyors themselves. This Association is doing much to bring about uniformity of action in practical operations. We remember well when we had to decide alone in the north woods the question of the course of a quarter line having one terminal quarter post. There was no one to consult, and no Association to kindly offer its advice. Law, or no law, there is much in these meetings to fix our practice, right or wrong, and we propose to advance. It is the *people* who need better legislation; the surveyors can get along as well as they have heretofore. The poorer the work done, the oftener it has to be undone; the better the work, the more lasting it is. Which is for the interest of the State? If here is not a field for some fair-minded legislator to step in and work for his district and for his State we do not know of one; and those who stand in the way of this progress will not stand very long.

DISCUSSION.

Mr. F. Hodgman.—Our Supreme Court has decided that certificates from County Surveyors cannot be accepted as evidence in law for the location of the corner or post.

Mr. D. Skeels.—A bill should be proposed and submitted to the Association at least one year before it is introduced in the Legislature. The office of county surveyor should be retained simply to maintain a system and a place for record of surveys. The present law does not fix the compensation of the surveyor, except for surveying whole townships.

Mr. A. Smith.—The law is intended to cover all cases. It has been my practice to charge expenses.

Mr. A. L. Drew.—The instructions given by the law should apply to every class of surveyors; the law should permit an assessment on the rolls to pay all surveyors.

Mr. M. H. Bailey.—The Committee on Geological Survey is not the proper one to which to refer a bill regarding land-surveyors. In Eaton

county the notes are deposited with the County Treasurer and the plan works well.

MR. S. C. HODGMAN.—Surveyors should have a uniform size of paper for field notes, and these notes should be deposited with the Register and be bound in a book provided for that purpose. The law should provide for prompt payment of the surveyor's bill; under the present method it may be two or three years before he can get his pay. The highway commissioner might be allowed to pass upon bills for surveying highways.

MR. H. D. BARTHOLEMEW.—A law requiring uniformity in size of paper appears to be practicable; it works well in the case of city and village plats and surveys.

MR. M. W. BULLOCK.—There would be more difficulty with farm surveys; for, while village lots are bought and sold by the plat, farms are not.

MR. S. N. BEDEN.—The system in use in Genesee county is very convenient; the c unty furnishes the book, which is indexed in such a way that any survey can readily be found. The book should be deposited with the Register.

MR. J. K. YOCUM.—The county surveyor should be retained; there should be licensed surveyors from whom to choose the county surveyor.

MR. T. W. PETTEE.—The Genesee county book is very good, but in some cases surveys have not been recorded. The book should be at the Register's office, a place more convenient for all who wish to use it, except the county surveyor.

MR. J. J. WATKINS.—Since the office of county surveyor is not a constitutional one, it has no reason for existence and should be abolished.

MR. I. H. LEAVENWORTH.—One legislative need is a provision in the law for the traveling expenses and board of the county surveyor.

MR. E. F. GUILD.—The law should say nothing about the price paid per day; the law of supply and demand should govern the price.

MR. B. KENT.—The records should be deposited with the Register of Deeds because the surveyor does not properly care for them.

THE NORTH LANSING MILL DAM.

BY A. D. BARTHOLEMEW, OF LANSING.

The questions to which I would invite your attention are two: First, what is the height of a dam? Second, how should you measure or determine that height?

Permit me to state the history of the case that called my attention to the subject:

On July 3 last I received a communication from the common council of Lansing, directing the City Surveyor to ascertain the height of the dam at North Lansing. I found, upon interviewing the mover of the resolution, that complaint had been made against the mill owners for raising the dam higher than the law allowed them, and that he thought the surveyor could settle the point in about 15 minutes; but after asking him two or three questions he became somewhat doubtful as to the time needed to obtain the required information.

The law under which the dam was built is Act No. 98, Laws of 1843, which limits the authority in these words: "not exceeding eight feet in height." No bench mark or data are referred to in the records as a basis for measuring the height, nor could I learn of any. I first examined the dam and its surroundings to become more intimately acquainted with it, although I had known it for over 23 years,—its partial destruction, rebuilding, repairs, and improvements at various times. It was originally built as a log and brush dam, on a full log apron or bed extending from 20 to 30 feet down the stream. In repairing and improving the dam heavy cribs have been placed 200 feet apart, and near each side of the stream, with diagonal wings extending up stream to the banks, while the bed of the stream in the center has been washed out below the dam, carrying away many of the apron timbers under the cribs, and for some distance out they remain apparently intact, lying as originally placed. The bed of the stream above the dam has been raised in different places from one to two or three feet by the deposits of silt and alluvium, while below the dam it has been washed out in places and in others piled up. There are reliable living witnesses who will testify that they have crossed the stream during a season of high water within 30 rods of the dam, when it did not cause even a ripple on the surface of the water. Again, during seasons of extreme drought, when the gates and dam had been well caulked on a Saturday night, on Monday morning the difference between the water below and above the dam was from 10 to 11 feet.

Becoming satisfied of the above facts, I decided to use the direct method and measured from the top of the old apron timbers to the top of the dam, and found at the west crib a height of 9 feet 3¾ inches, and at the east crib, on which side is the mill race, 9 feet 7 inches.

When the result of my report was published, a stormy war of words arose among the interested parties, and the town at once became apparently well stocked with old, experienced, competent, graduated hydraulic engineers. They were not a unit, however, in their opinions, although they mostly claimed that a series of observations should have been taken of the level of the water above and below the dam. Some claim that these levels should have been taken every one, two or three months for a year, and the average struck, while others claim that these levels should have been taken at intervals of from one to four miles above and below the dam and an average struck.

Not knowing but I had made a grave mistake, I at once commenced a search for light on the subject in order to post myself theoretically. I wrote to *Engineering News*, stating my questions in the general form, and asked for the title of the best work on the subject. The editor passed my note to the Holyoke Water-power Company, Massachusetts, and I received a reply from their hydraulic engineer, Clemens Herschel. He referred me to a law book, "Angell on Water Courses," but did not answer my questions, merely saying, "As is frequently the case it seems to be a very pretty problem as it stands."

In the above book I found no direct answer to my questions, although I found one case bearing on averages or carrying a level up or down a stream, Brown v. Bush, in 45th Penn. Statutes '61. The owner of a tract of land, in improving his water-power, removed a natural dam across the stream, which consisted of a ledge of rocks, and built a dam lower down the stream. He was sued for flowage. His defense was the testimony of the engineer who had taken the height of the old natural dam and of the new one, and who claimed from his measurements with his instruments that the water was no higher than formerly. The prosecution introduced witnesses who claimed from actual visible facts, such as marks on rocks, bridge abutments, posts and trees, that the water was higher. The verdict was against the mill owner, who carried the case up; but the superior court confirmed the verdict, affirming that actual visible facts were more reliable than measurements with instruments. I also wrote James Leffel & Co., Springfield, Ohio, stating the questions, and ordering their work on the Construction of Mill-dams. No light appeared in their work, and their answer to my note, written by an employe, was not satisfactory. He said, "The proper way to measure would be from the top of water standing in dam to the top of waste water below the dam near by." This is manifestly incorrect if the water stood in dam as it frequently does, two or three feet below the crest of the dam. Again he said, "In other words, a dam eight feet high would be a dam

built eight feet above bottom of stream." Webster defines bottom as the lowest part, and in the present case, when no one claims that the dam is over 9½ feet high, the distance from the lowest part of the stream to the top of the dam is 12 or 13 feet. I again wrote the firm, asking how to determine whether the present dam was higher or lower than the law contemplated. The answer was that it could not be determined without the bench-mark or other data any more than you could re-survey a tract of land without the field notes.

In the meantime I have kept watch of the height of the water at the dam, and have repeatedly observed that, soon after the water had ceased to flow over the dam and the mill had shut down, the variation in the levels of the water below and above the dam was the same as I gave for the height of the dam. During the fall I met some of the mechanics who were on the dam when it was last repaired, and they claimed that it was raised 16 inches higher than the old one, making the height 6 feet, 4 inches, while I measured it as 9 feet, 3¾ inches.

The foregoing are all the facts and fancies (otherwise theories) that I have been able to learn during six months, and I must confess that I am still unable to formulate a satisfactory answer to the question, What is the height of a mill dam? The following is the best that I have found: The height of a dam is the distance from the surface of the water below the dam up to the level of the crest of the dam when the mills are running and the water stands above the dam even with it. But this will not apply to submerged dams that are always buried. Would the answer be affected by the condition of the dam, whether it was a very close, tight one, or a very poor, leaky one?

Of course no proper answer can be made to the second question until the first is answered, for how can we measure a thing until we know what that thing is.

DISCUSSION.

MR. S. N. BEDEN:—Related an instance where the water flowed back to an elevation much higher than the crest of the water at the dam.

PROF. R. C. CARPENTER.—This back-water or standing wave is mentioned in all exhaustive treatises on hydraulics, but the rules for estimating it are approximate and depend on complicated, and often obscure data.

MR. WM. THORNTON.—I made, when younger, numerous experiments in regard to backwater caused by dams, but became satisfied that no rule could be depended on to give the depth of backwater at any distance. Its effect was greater in a stream with moderate fall.

WOODEN PAVEMENTS.

BY H. G. ROTHWELL, OF EAST SAGINAW.

Engineers from ancient to modern times have been largely employed in the construction of permanent way for land carriage. No branch of the profession has had more study given to it, or called upon the skill and ingenuity of the engineer more largely.

Engineers, to be successful, must prove themselves fruitful in resources, turning to account in the best and most efficient manner the various materials at hand in the workshop of nature. The discussion of the various materials and modes of construction thus brought forth from earliest time to the present would, were I able to do justice to it, be one of the best illustrations of the energy, skill and perseverance of the engineering profession. I shall confine myself to wooden pavements and their mode of construction, more particularly cedar block pavements, one of the most recent forms.

Wood, from its abundance, especially in this country, has been much used for road covering,—from the primitive corduroy to the most elaborate of patent wooden pavements—and with various results. Its rapid decay has been one of the most serious drawbacks, only offset by its cheapness and general accessibility. There are also sanitary reasons given by many against its use in cities. This charge is a serious one, and if we are obliged to use this material, we must call in the assistance of the chemist, with, I think, good results.

In the city of London the Burnett process has been tried and is thought not only to preserve the wood from decay but also to increase its wearing qualities. Wood has however in that climate proved a very slippery pavement when treated in this manner.

The mode of construction was, as I understand, as follows:

The road bed, after being first properly graded to a sub-grade, was covered with a layer of broken stone of a depth of 6 inches when rolled in with a heavy steam roller; next was laid a bed of gravel and sand 3 inches deep, on which were placed the burnettized blocks, 8 inches in depth. The wood used was spruce, and any porous wood was considered applicable. The interstices between the blocks were well filled with good clean gravel, a dressing of fine gravel and sand placed on top, and the whole well rolled down again with a heavy roller. The wear of this pavement is said to be at the rate of ½-inch a year in most exposed places, and the cost, including $11 per thousand b. m. for burnettizing, is about $3 per square yard. They are now using cedar in Liverpool for wooden pavements (or simply as a covering), and I understand with good satisfaction thus far, although they have

not had time to test its durability. This pavement is used for streets, travelled by carriages and other light vehicles, and it recommends itself by its noiselessness and by being less slippery than asphalt.

The Nicholson patent wood pavement has been much used in this country, and where honestly put down has proved a very good covering. There is some in our city (East Saginaw), that has been laid 14 years, but we shall be obliged to take it up this year. The boards under portions of it which have been taken up for sewer and water connections have proved quite sound. Tar was plentifully used in these pavements. The wooden blocks have not been really worn out, but have suffered from dry rot. The various other patent wood pavements, such as the McGonegal, Wychoff, etc., have, in the main portion of their specifications, differed but little from the Nicholson, and have given various results in wear, not, however, I believe, so good as the Nicholson.

Cedar, on account of its accessibility and cheapness, soon recommended itself to the attention of engineers, and thus far has proved a cheap and apparently durable pavement. When first used the mode of laying it was, I believe, as follows: After the road bed was properly graded, it was covered with a layer of not less than 6 inches of bank sand rolled in, a layer of inch boards laid on top of the sand, and the boards tarred on top. The blocks, cut 8 inches in length, were then placed on the boards, and the interstices filled with clean gravel; the pavement was then swept and given a coating of hot tar, after which it was top-dressed in the usual manner. It was found that the manner of laying was dry-rotting the pavements, and engineers left out the boards in their specifications, but retained the tarring process on top and in some instances increased the amount of sand ballast. They then resorted (in order to strengthen the pavement) to the insertion of keys or wedges, consisting of cedar cut 15 to 18 inches long, split into stakes and driven here and there, through the interstices of the blocks, into the sub-soil beneath. The results of this practice, so far as I am able to learn, have not been entirely satisfactory. The blocks still continue to dry-rot, but it is a curious fact that the keys when taken up are generally found perfectly sound.

Engineers then began to leave out the tar, finding that its use on green timber was detrimental, particularly from the superficial manner in which it was generally put on. I have some samples with me which show for themselves.

I have differed somewhat in my specifications from those already quoted and generally carried out.

After the road-way is properly graded to sub-grade, I place upon it 3 inches of river sand, packed and scraped to grade. I then place a layer of inch boards with inch stringers below, one under the ends and one in the center of each course of boards. I then place 7-inch blocks on the boards, properly filling the interstices with good clean gravel,

well rammed in. After the pavement is swept off for inspection, I top-dress with fine gravel and sand, *without tar.*

None of these pavements are old enough to demonstrate whether this is a better plan. The average price per yard last year of these pavements, with Medina stone curb and average excavation, was $1.25 per square yard, including everything.

My reason for reducing the sand filling to 3 inches was to allow the moisture from below to get to the boards and blocks. My preference for river sand is first on account of its resistance to pressure and second because it can be readily obtained; I also find that it retains the moisture better than does bank sand. I continue to use boards, as they give a more uniform foundation and smoother pavement, reinforcing the crown of the street and distributing the pressure of loads over greater bearing surface. I find, where I take up some of this work, that the boards and blocks are moist, as is also the sand underneath the boards. The pavements are thoroughly sealed and no perceptible amount of moisture is found at the surface.

Satisfied that of all wood pavements the cedar blocks have so far proved the best, and that even yet we have never fairly worn one out, but that some have dry-rotted, I bring this matter before you, hoping that, by comparison, it may clear up some of the discrepancies which exist, and that we may finally furnish to the people the best method of improving our streets for the least cost to the property holders.

DISCUSSION.

MR. H. D. BARTHOLEMEW:—Explained how a pavement was built in in the centre of Michigan Avenue, at Lansing, simply wide enough for two teams to pass, the blocks being held in place at the sides by planks on edge.

MR. E. F. GUILD.—The same kind of pavement was laid in Saginaw, and has given satisfaction.

WOOD PAVING SPECIFICATIONS FOR CITY OF EAST SAGINAW.

Clearing.—From that portion of the street included in these specifications, all roots, brushwood and rubbish of every description, shall be removed from the street and disposed of by the contractor. This work of clearing will be considered as included in the price paid for grading. From such portions of the street on which planks are laid, such plank and the stringers supporting them shall be removed by the contractor, and by him piled compactly on the side of the street where directed by the street commissioner.

Payment will be made for this work by the cubic yard, at the price to be paid for excavating and filling. All bridges, platforms, crosswalks, plank and stringers, hitching posts, etc., on the line of the improvement, shall be taken up by the contractor, with as little damage as possible, and carefully preserved. The owners of said walks or platforms in every case must be notified of such removal. Upon the completion of any portion of the work, all earth, rubbish, refuse

stone, blocks and surplus materials are to be removed, and the street in all respects put in a clean and orderly condition.

Grading.—The street to be graded to its established grade, and to be excavated to such a depth below the true grade as the city surveyor may deem necessary for the purpose of receiving ballast for the road-way.

The bottom of excavations, when completed, shall conform to a section or crown of the street as furnished by the city surveyor. If there are places in the street, which are not firm or properly settled, caused by trenching or connections of sewer, gas and water pipes, the earth must, if deemed necessary, be taken out and the space re-filled, and pounded to make it solid. Before placing the ballast thereon, the road-bed in each block shall be well rolled with a roller weighing not less than 2,400 pounds.

If the contractor shall excavate deeper than the grade specified by the city surveyor in the drawings of sections and profiles, the same shall be filled with bank sand and gravel at the expense of the contractor.

The earth taken from the road-way to bring it to the prescribed sections, is to be deposited in the old earth ditches and evenly spread, the surplus earth to be disposed of by the contractor.

The filling or excavation, when brought to the proper depth below the grade, shall be smoothly graded, shaped and rolled with a roller weighing not less than 2,400 pounds, to conform to the crown of the pavement, that the ballasting, gravel and sand will be of uniform thickness.

Sidewalks.—The sidewalks, a width of.....feet on each side of the street, are to be leveled off or filled up, as the case may require, to bring them to an even slope, from the outside lines of the street to the curb. The inclination from the street line to the curb shall be not less than.....feet.

In all cases where the sidewalk is to be laid the full width, the contractor must excavate or fill, as the case may require, sufficiently to receive the sidewalk plank on a level with the top of the curb, or such a depth as the city surveyor may direct. The old sidewalk plank must be taken up with care and with as little damage as possible and compactly piled on the property adjoining. The contractor will not be required to re-lay the sidewalk. Payment for this work is to be included in price bid for grading.

The contractor is to take special care of all sewer man-holes, water valve boxes, gas pipes, or other public fixtures in the street, such as monuments, etc., and will be held accountable for all damages or injury to the same.

Ballasting.—A bed of river sand, not less than three (3) inches in depth, shall be placed upon the road-bed previously prepared to receive it, and shall be evenly spread and rounded to the shape of the street.

Wherever sand and gravel is specified, it must be of the best quality, and subject to the acceptance of the person or persons designated or appointed by the common council to accept the same.

Boards.—After the ballast has been rolled in, a layer of inch boards not less than ten (10) inches in width and sixteen (16) feet in length, (shipping culls) laid according to plans, with stringers of inch boards, set every eight (8) feet, or one under each joint and one in the center of each course of boards.

Blocks.—Blocks to be stripped of the bark, of cylindrical shape, and sawed from Cedar timber, with a sap not exceeding one-half (½) inch in thickness. All blocks shall be cut from good sound live timber, free from defects, and shall not measure more than ten (10) or less than four (4) inches in diameter on top, and not less than seven (7) inches in depth, and so placed as to make as near as possible the spaces of uniform size. The blocks must be laid to an even and uniform surface.

No teaming shall be allowed over the pavement until the spaces are properly filled in with gravel. The contractor must, in all cases, have sufficient gravel on hand to ballast the blocks, and no block laying will be permitted unless there is the proper gravel to fill the interstices as the work progresses.

Spaces.—The spaces between the blocks to be filled with screened gravel, free from sand or dust and rammed in till solid, with iron or steel bars, then covered and refilled, and then swept off with a coarse broom. This ramming must in no case be omitted.

Top-Dressing.—The pavement shall be left uncovered until the same is inspected by the person or persons designated or appointed by the common council to accept the same, and when inspected and accepted, the whole surface shall be covered with fine gravel to a depth of three-quarters (¾) of an inch. All gravel used for filling and top-dressing shall be subject to the inspection and approval of the person or persons designated or appointed by the common council to accept the same; and all material which shall be rejected by him or them, shall be immediately removed from the street.

Curb Stone.—Shall be of the best Medina sand stone, not less than thirty (30) inches in length, of a depth of eighteen (18) inches, and four (4) inches in thickness, and show a fair face above the paving. It must be set in a bed of bank sand and gravel, and incline one-half (½) inch from the street, and the top dressed to the bevel of the sidewalk. The joints dressed to the depth of fourteen (14) inches, and the back filling to be four (4) inches of bank sand and gravel, and firmly pounded. At all corners and intersections of streets the curb shall be set with a curve, which shall return the gutter easily to the street basins.

The setting of the curb stones must be done by experienced workmen, and will not be accepted unless they are set to the true line and grade.

Wing stones will be four (4) inches thick, two (2) feet in length and eighteen (18) inches in depth, and dressed to the proper angle. The stone shall be of the same material as the curb stone used on the street.

Crosswalks.—Crosswalks are to be constructed across said street and across all streets intersecting said street, if so required. Said crosswalks to be of cedar blocks similar to the pavement.

The center of crosswalks shall be at such height above the grade of the street as the City Surveyor may direct.

Culverts.—Culverts shall be placed where required by the City Surveyor; they shall be twelve (12) inches in width, to be formed of curb stone of the same quality and description as that used on the street; to have oak covers fitted on them, consisting of 2x2 inch plank of the proper length of the culvert, supported on iron rods, as shown on the plan.

All material used, shall be of the quality specified, and the mode and manner of the performance of the work shall be subject to the examination and approval of the person or persons designated by the common council to superintend, inspect and accept the same.

WATER AS A SOURCE OF ENGINEERING DIFFICULTY.

A GOOD SERVANT BUT A POOR MASTER.

BY CHARLES E. GREENE, OF ANN ARBOR.

Ancient philosophers have written of four elements, earth, air, fire and water, and the idea was maintained among the Greeks for some time that water was the primal element or principle of matter; for it was long supposed that the four elements were mutually convertible. Thus heat, or fire, converted water into air, that is steam, or invisible vapor; repeated evaporation was thought to convert water into earth, as a sediment was usually left, especially in crude attempts with an impure article; so that there seems to have been an original idea that water was the sole element. These notions only provoke a smile at the present day.

I do not propose to treat of water in a chemical way; nor do I intend to touch upon the hydraulic point of view or the varied industrial uses to which it is put unless, it may be, incidentally; but I shall endeavor to show that water is the source of the greater part of the troubles which a civil engineer experiences, a foe with which in many varied aspects he has continually to cope and which he must endeavor to turn aside or hold in check. The architect and builder must guard their constructions against dangers arising from fire, and, as heat is a necessary means for accomplishing many ends, it has become a common saying that "fire is a good servant but a poor master." The same proverb may be applied with greater force to water, by the civil engineer, for, while it serves many useful purposes unnecessary to be mentioned, damage and great pecuniary loss result too often when, from the lack of foresight and the absence of simple precautions, it it allowed to get the upper hand. I propose, then, to point out some of the ways in which water may cause trouble, expense or failure of plan. An engineer on any work of construction or improvement should keep well in mind, when originating and carrying out his projects, the necessity for adequate provision for this element, and should study carefully how such provision can be at the same time thoroughly and economically made. He will have to deal with it in some form in most engineering constructions, and in all cases can rest assured of the truth of the homely proverb, "an ounce of prevention is worth a pound of cure."

If I do not always attempt instruction as to remedies, I hope that the suggestion of the directions in which trouble and danger lie may

indicate to your own minds the proper course to pursue. I will begin with instances with which you are more or less familiar.

The Road-bed.—We have seen common earth roads, such as are found on prairie or clayey soils; sometimes an attempt has been made to form a road-bed; sometimes there are merely the wheel tracks to distinguish it from the adjacent soil. These roads are quite tolerable during the dry season, but in the wet months or after any serious storm they become quagmires and sloughs of despond. Frequently no provision has been made for drainage and diversion of the rainfall. Standing water is ruinous to any road, and water in the side ditches, unless quite a distance below the road-bed, soaks into the foundation of the road, rises by capillary action, and keeps it soft. All road ditches should have an outlet. A sandy road may be reasonably satisfactory in wet weather, for the water will drain rapidly away, if it has a chance. A compact and well-shaped surface to shed the rain, good ditches to lower the water-level in the ground and carry off the rainfall, and underdrainage in particularly bad spots, will work wonders in improving an ordinary dirt road. Ruts afford lodgment for water and give it time to soak into the road-bed. Underdrainage will increase the supporting power of the soil by increasing the frictional resistance to displacement. Macadamizing the surface of a road-way secures the hard impervious surface which is so much to be desired, and the stone foundation of Telford will assist the drainage of the subsoil, as well as distribute the pressure over the stratum of earth below.

The state of an ordinary road-way in early spring, when the frost is coming out of the ground, as it is called, is too well-known to need description. The absence of water from the surface material, when protected by the impervious top layer, will insure at that time a firm and solid road without ruts and mud.

Gravel and broken stone ballast is put upon roads as well as railways to furnish a well-drained surface to carry the traffic. Were it not that the presence of much moisture is detrimental to a road-bed, any material would answer as well as gravel, and corporations would not go to the expense of securing the material actually required, often bringing it from a great distance. I know of a city where gravel for its streets is hauled some five or six miles. The practice of plowing and scraping the sods and loam from the ditches and sides of the road to the centre is not conducive to the formation of a road-bed which sheds water well. The reason is now seen why broken stone, slag, gravel (the coarser the better), sand and loam have merits as ballasting material in the order mentioned, and it is also evident that clay, from its property of retaining water, is the worst material for the surface of a road. Ballast in cuts will be of little benefit unless the side ditches are kept open and have sufficient fall. These remarks apply equally well to highways and railroads. Ties or sleepers exposed to moisture with access of air rot very fast; hence the railway road-bed should be well

drained for the purpose of lengthening their life. The frost will heave the track less if the ballast is as dry as it is practicable to keep it.

If the bottom of a cut is wet during construction, especially if the earth is of a clayey nature, it should be kept constantly drained by ditches, as thoroughly as possible; for the passage of teams and loaded wagons will otherwise cut it up badly, producing a most tenacious mud and greatly increasing the cost of excavating. It is better sometimes to let a cut alone for a day or two after temporary ditches have been made, so that it may dry out more or less. In a very wide cut it is frequently necessary to lay planks for the wagon-way during grading.

Erosive Action of Running Water.—Running water has been used for conveying sand and earth moderate distances with economical results. In the hydraulic mining of California enormous quantities of loose rock, boulders and gravel have been washed away in the search for gold, and the tailings have choked up some of the rivers of that State to an incredible extent. We there see on a small scale the work of that agent which, in geological times, performed the principal part in forming what is now the habitable portion of the earth, denuding mountains, filling up valleys, disintegrating and rearranging the materials of the earth's crust.

A western paper says that an inch hole, under a head of 6 inches of water, will discharge 2,250 cubic feet or 17,000 gallons in 24 hours, and that this quantity, a miner's inch of water, on a grade of 4 inches to a rod, or 2 per cent., will carry off, in 24 hours, a distance of ten miles, ten tons of heavy quartz, sand and iron. Small streams or currents of water, if running with considerable velocity, have a great erosive and transporting action. The little rills which course down the ruts and wheel tracks of a roadway of even moderate grade, during and after a rain, will cut out and carry off a large quantity of the ballast unless it is very firmly compacted, damaging the surface very materially, leaving the debris where it is not wanted, and often choking badly the ditches. Hence the road surface should be rounded or sloped transversely, to turn the water to the sides, and, on hilly roads, slight dams, called water bars, are often made so as to insure the diversion of the water which would otherwise pursue the line of steepest declivity. When a road traverses a side-hill, and there is danger that the ditch on the up-hill side may become filled and overflow, passage for the water should be provided across the road at frequent intervals, or else it may choose its own path and injure the travelled way.

The same action occasionally takes place on the road-bed of a railroad where the track has been lifted with ballast at the ends of the ties, but not yet filled in the middle. The ties, however, offer an obstruction to any great action of this sort. The finished grade, before track is laid, if left for any length of time, is not unfrequently cut and gullied by the running water, especially if it is suffered to remain with the wheel ruts unfilled which were made during construction.

The erosive and transporting power of water is also manifested, to the constructor's sorrow, when the rain trickles down the slopes of a newly made bank or cutting which has hardened enough to prevent the water from quickly soaking in, and has not stood long enough to gather a coating of grass and weeds. Clay slopes, on which a growth does not readily start, will wash badly for years, and we have all seen the ragged appearance which they present. In cases where the expense will be warranted, the slope is dressed with loam or even sodded. Such slopes are rendered permanent by the protection of the grass.

The washing is more extensive on the up-hill side of a cut, for the rain which falls on the slope is reinforced by the water which runs down the hill above, and the damage is more serious, because the washed material, besides filling the ditches, is left covering the road-bed, whence it must be removed. On a railroad it gets mixed with the ballast, and has sometimes accumulated so rapidly in a severe storm, as to be the cause of bad accidents. A ditch at the top of the up-hill side of the cut will arrest and divert this water, but the ditch must be made with care or it may be the cause of a cracking and slipping of the side of the cut, as will be seen later.

Culverts.—Culverts must be provided across any line of communication at all points where water naturally runs in the wet season, unless it can, in some cases, be safely turned to another channel. Such diversions should be cautiously made, so that the new channel shall be sufficiently large and its sides protected against washing away, especially at the place where the natural course is checked and if the current is swift. Loose stones of sufficient size, called rip-rap, and brush, are serviceable protections against a washing of the bank.

The water way of culverts is frequently made too small. As surveys for rail or other roads are not, in many cases, made during the wet season or in early spring, and as construction is frequently pushed on rapidly, the engineer must rely on other data than a personal inspection of the maximum flow of water to determine the area of opening needed in his culverts. He desires to waste no money by making them larger than is needful, or by putting in any superfluous ones; but, if they are too small, a damming up of the water in time of freshet may occur, with a washing out of the bank by overflow, or a blowing up of the culvert under the increased head with the same result. A ponding up of water from the lack of a sufficient outlet and the subsequent breaking away have sometimes also been the cause of great damage to the property down-stream from the impetuous rush of the flood thus liberated.

The information which can be obtained from residents in the vicinity as to quantity of water likely to traverse a particular course is sometimes valuable and sometimes the reverse. An engineer's better judgment of what provision it is necessary to make for the passage of water may be strangely warped by his desire to make a low

estimate of cost, even in cases where he knows better. I have seen a remarkable instance cited: the engineer's preliminary estimate of cost of construction of the Hudson River Railroad, 145 miles long, showed only 16 or 18 culverts; whereas the Croton Aqueduct, built just before by the same engineer, traversing 40 miles of the same route and close to it, had over 300 culverts, arches and bridges in that 40 miles.

Little depressions which may apparently be safely dammed by the embankment without any opening may afterwards contain a pond of water which will soak into the bank, causing it to slide down, and making a cave at one side of the road-bed, or the water may overtop the grade, when it will quickly cut a deep and wide gully across the embankment, rapidly washing out the bottom and undermining the sides of its channel. Such a washout may be quite extensive from an apparently insignificant source.

The rapid melting in some springs of the accumulated winter's snows, accompanied by a warm rain, will tax culverts most severely which would have ample waterway for ordinary seasons. At such times streams of large size pour down from runs and depressions of small watershed.

As the ice on the rivers will break up in such a general thaw and rise of water, bridges are put in imminent peril and often lost. An ice gorge will raise the water above it to a great height and flood property which is usually far out of reach of danger.

Culverts of an area sufficient for the passage of water may, in some locations, become clogged with drift wood, branches of trees, brush, cornstalks and other floating rubbish, so that the water will be dammed back, with serious results. Hence arises an objection to passages of several openings, side by side, as in the case of pile culverts of three or more bents. Below culverts a free and unimpeded egress for the water should be provided.

The increased velocity of the water in the culverts, if the opening is narrower than the natural waterway, makes necessary a good protection to the bottom of the culverts to guard against scour, and a placing of masonry foundations at a greater depth. The tendency of the stream on its exit from the culvert to cut out the bottom must be carefully prevented, as a hole begun there is rapidly enlarged upstream and will probably undermine the structure. The bottoms of culverts are protected by paving, cross-timbers, planking, cross-walls, rip-rap, or other means suited to the locality.

Current Action in Rivers.—Scour of the bottom of a river, if of soft material, is not unfrequently caused by the construction of piers for a bridge, and the deflection of the current by such piers may cause damage by the diversion of a navigable channel, or erosion and caving of the bank and the deposition of the transported earth to form a shoal or bar somewhere below.

The caving of river banks, the shifting of the channel, the formation and cutting away of bars, can be seen in progress on our western

rivers. This branch of our subject will not be enlarged upon here, for the study of causes and remedies would take too much time, and would perhaps fail to give satisfactory results. The wearing away of the bank in a bend of some powerful river is very rapid. For instance, at the town of Covington, Iowa, on the Missouri river, an Iowa paper in 1880 said: The ground on which the court house stood a year ago is now covered by many feet of fast-flowing water. A week ago Sunday the current set in shore and took off a strip of land 30 feet wide in a few hours. No invasion was made for another week, when another slice was cut off. Then about half a dozen buildings were moved back some 30 feet, and the next day the land on which they stood was all gone. The citizens have tried to moor trees and logs to the bank in the hope of forming a barrier for the flood, but the current is so swift and the water so deep that these attempts have failed. Two years ago there were 600 feet of land between the principal hotel and the river bank; now you can toss a stone out of the window into the water, and the building is on rollers for removal.

On April 27, 1876, the neck of land opposite the city of Vicksburg caved in, and the rush of water at once poured through the opening so made, tearing away the banks and deepening the cut to such an extent that steamboats passed through the same day.

Slides and Land-Slips.—The slope at which earth will stand is affected by saturation with water, where such saturation diminishes its frictional resistance to slipping. The slope of loose rock is very little, if any, disturbed by immersion in water, coarse gravel somewhat more, sand to a greater degree, and loam most of all. Clay when wet thoroughly will not stand at any slope. An embankment made of frozen clods of clay with ice and snow mingled is likely to spread and settle to a marked degree.

Slips of the sides of cuttings occur in some cases, where the earth has apparently been sloped sufficiently. Such slides are due, generally, to water in inclined underlying strata; they are very troublesome to deal with, or to check after the movement has begun. They may sometimes be prevented by draining out the water, by holding the earth in place by constructions performing in a greater or less degree the function of retaining walls, or by removal of the earth to a much flatter slope. Several papers, reciting the employment of successful means of checking slips in cuttings, have been read before engineering societies within the past few years, and may be found in volumes of transactions and technical periodicals. Occasionally a slip on both sides of a cut, when the toe of the slide has extended beneath the road-bed, has been known to raise the road-bed very decidedly. A ditch at the top of a cut is thought by some to be likely to cause a slip, by the soaking in of the water. Sometimes a wet, clayey substratum, laid bare in excavation, is crowded into the cut by the pressure of the superincumbent mass.

Earth on a side hill, which has a wet stratum underlying it, is

sometimes in such unstable equilibrium and so near movement that an excavation may remove the needed support, or an embankment may add the pressure which is sufficient to start the slide, when the whole hillside may go. Occasionally the movement is slow, more often it is rapid and disastrous. Cleveland and Cincinnati have furnished examples of land slips. A notable one occurred at Westbrook, Maine, completely filling and damming back a river of considerable size. Last year the Erie Railroad, to lessen a grade between Portage Bridge and Castile, put in a loop line which makes a detour through a hill of quicksand and over a deep ravine. At the bottom of the ravine is a culvert on pile foundations extending down to the rock. The superincumbent weight upon this treacherous mass of earth caused the whole to sink, while the lower material began moving down the ravine. Large forest trees were carried downwards toward the river bank, and fears were entertained that the whole embankment would slide out of position. The bank was raised three times within as many months. Mr. W. W. Evans gives another remarkable instance of a land slide. He says: On the line of the Oroya Railway in Peru, in the valley of the Rimac, a railroad embankment was built across the mouth of a ravine. Water in small quantities from melting snow above had been dammed back by the natives and used for irrigation. This water had permeated deep through the soil of the side hill, and one day, overweighted by the embankment, "5,000,000 cubic metres of rock and earth, gravel, mud and water came rushing into the valley, crossed its whole width of 1,400 feet, surged up against the opposite side, rolled over and crushed out of sight all the houses in its annihilating course, and filled the valley with a dam 1,600 feet wide on the bottom and 108 feet deep. The average vertical fall of this vast body of earth was about 1,500 feet and the horizontal movement over 5,000 feet." He adds: "Surely water has power, and we are entitled to place it with its sister element, fire, as good servants, but dreadful masters."

Besides the landslips and rocks falling down the side of a cut after severe storms, we meet with the effects of frost as seen in the spring. The expansive action of water freezing in crevices loosens such material as is cracked, and, when thawing takes place, fragments of rock and the sides of hard clay cuts which, to save in first cost of construction, have been left standing at too steep a slope, scale off and tumble down. The talus at the foot of rocky precipices is the result of this action through a long series of years.

Quicksand owes its peculiarities to saturation with water, which reduces its frictional resistance and makes it most unstable, especially if subjected to vibration. It gives no trouble after it is drained, if such drainage can be effected, and it is reliable as a foundation when closely confined in place, as can sometimes be done at more or less expense. An example is given later.

Retaining Walls.—If masonry retaining walls are not provided with

means for allowing water, which would otherwise collect behind them to escape, they must be built stronger than otherwise would be necessary to resist the pressure from saturated earth. The presence of water in the rear may also render the foundation insecure, as its percolation in that direction may increase the tendency of the base to slide outward. There is not unfrequently danger of slipping at the base when the foundation rests on a clayey stratum in which water is found, and the tendency to slide will, in some cases, only be obviated by special constructions at considerable expense.

The presence of moisture in the rear of a retaining wall causes the earth to heave in freezing. The expansive force exerted is very great. An inclination of the back of the wall at the upper part, termed a "frost batter," rendered smooth with cement, will guard against this heaving of the ground, by allowing the frozen earth to expand mostly upward. A layer of loose, round stones is also useful in the rear of the wall, to prevent the earth from freezing to and lifting the masonry, and to facilitate drainage. The bulging of some walls, increasing from year to year, until the wall is thrown down, is due to this action of frost in the rear. Hence gravel is much better than clay for the backing of walls.

Timber.—Seasoned timber, not prepared by any special process, but protected from dampness and exposed to a free circulation of air, will last for centuries, and so will timber in excessively dry climates. An equal, if not superior durability in timber is observed when it is immersed in fresh water, or imbedded in thick walls, or underground, so as to be beyond the influence of atmospheric changes.

Of these facts numerous proofs might be cited. The trusses of the old part of the roof of the Basilica of St. Paul, at Rome, were framed in 816, and were sound and good in 1814, one thousand years. These trusses are of fir. The timber work of the external domes of the Church of St. Mark, at Venice, is more than 810 years old, and is still in a good state. Sound logs are dug out of bogs where they have lain for an indefinite period. Piles driven by the Romans have been pulled up in recent years and found undecayed.

But the best seasoned timber will not withstand the effects of exposure to the weather for a much greater period than twenty-five years, unless the surface is protected by paint, or some other coating to keep out the damp, or the wood is treated by some preservative process. The ordinary life of unprotected timber structures is not more than one-half or two-thirds of the above time.

Timber exposed to moisture in the presence of air, especially if in a warm place, or to alternate wetting and drying, will decay rapidly. Sap and moisture retained in timber, by painting or closing in the sticks before they are seasoned through, will cause decay of a very insidious kind, as it works in the interior, leaving an apparently sound exterior or skin, which is the layer that had an opportunity to season. Paint on unseasoned timber is, therefore, more hurtful than servicea-

ble. Large sticks of timber dry so slowly that, before they are seasoned throughout, decay may begin, and hence pieces of small scantling are preferable to large ones. Dampness and a lack of ventilation combined will hasten decay.

In all timber construction exposed to the weather, mortises, pockets and places for the lodgment of water should be avoided. If mortises are necessary, an exit should be provided for any water that may run in, by boring a drip-hole or otherwise. Joints which may get wet and cannot readily dry out should be carefully avoided. It is well to paint with a white lead paint all joints just before the timbers are put together. Painting the ends hinders checking. To pack timbers closely together is objectionable. The capillary action of small crevices or joints will draw in water to some degree.

The ends of Howe truss covered bridges should be well protected from the driving in of storms. The ends of the lower chords, bolsters, bottoms of posts and main braces, all coming together there, often decay very soon, if neglected. Iron rods rust and are reduced in section from the presence of moisture. Wood which checks badly in drying will not last well, as the season cracks admit water to the interior of the stick. This checking has been urged as an objection to tamarack ties. Hewed timber will shed water from its surface better than timber which is left rough from the saw. This may be a reason why hewed ties are thought to be better than sawed ones.

Roofs and coverings of timber construction must be made watertight. Not only must cracks and leaks in valleys and elsewhere be guarded against, but possible movement from change of form under varying load or temperature must not be allowed to open a way of access for water. Water will sometimes back up quite a distance under slates and shingles near the eaves when the gutters are filled with snow.

Dams, Embankments, and Levees.—In the formation of water power and the storage of water for other purposes, dams and embankments must generally be constructed. To be permanent they should be most carefully built. The engineer is then brought face to face with a prisoner, as it were, and must keep him closely in restraint, or led in fetters to the task which is allotted, and must remember that the water, pressed forward by the superincumbent mass, is constantly searching for any loophole or crevice of escape. As a writer on hydraulics remarks:

"Under the intelligent control of man, the power of water is one of the chief instrumentalities in promoting human comfort and spreading the blessings of civilization. The uses to which it may be turned are so various, and the products for the manufacture of which it is a serviceable agent are of such manifold forms and minister to so many wants of our nature, that the country which is possessed of abundant water power is looked upon as especially favored by Providence. But this invaluable servant, if once it bursts over the bounds

which have been set for its action, becomes a destructive scourge, laying waste the very fields whose tillage it had made profitable, and bringing to poverty, in an hour as it were, a whole community, whom until then it had sustained in prosperous industry."

The dam or embankment must be united to the foundation on which it rests with a water-tight joint. A permeable foundation will give the most trouble, but moderate filtration through such a bottom may do no harm, if the water has to traverse a sufficiently long path, owing to breadth of base or obstacles in its way, so that the frictional resistance will reduce the pressure practically to zero. Water may then soak through without having the power to remove the earth or sand. The loss of water in this way is of no consequence in an abundant water power, but is more likely to be objectionable in the case of a reservoir, both on account of the loss and from the inconvenience which leakage may cause to adjacent property. There still remains the danger that the increased head from rise of water in time of freshet may increase the leaks to the point of bringing away the material through which the water percolates; when a washout will ensue in most cases. Thus leaky dams have stood for a number of years, and then failed rapidly at some time of unusually high water. So long as the issuing water is clear there is no immediate cause for anxiety, but when the flow is turbid the danger is imminent, and heroic measures for stopping the leak must at once be applied. The ends of the dam must be prolonged a sufficient distance into the banks to cut off any escape for the water in that direction.

Waves will eat rapidly into the edge of an unprotected earthen embankment, unless the upper portion is made as flat as an ordinary beach of such material. Grass, growing plants, brush, loose rock, etc., serve as a protection. As to the body of the embankment itself—the insidious way in which a thread of water will make its way under a head of pressure through small cracks due to shrinkage and settlement in earthwork not carefully consolidated, or will follow along timber which traverses a bank, needs to be seen to be appreciated. Clay puddle is the material most commonly used for making the banks and bottom of a reservoir tight. A good masonry wall is sometimes built in the interior of an earthen bank. Muskrats and crawfish bore holes in reservoir banks and in river levees, and sometimes start a leak.

Culverts, pipes, and other constructions leading through the bank or dam are sometimes a cause of trouble from water finding its way along their exterior. Such exterior should be left rough and have flanges or rings projecting at intervals to check this leakage. If water is forced to traverse several right angles in its passage, its head will be very much reduced.

The Lynde Brook dam of the Worcester Water Works broke away in March, 1875; in the floor of an archway under the dam the water from a leak, after running harmlessly for some time, began after a

heavy rain to bring away earth, enlarging the leak and next undermining a portion of the culvert, which then fell in; a break in the dam ensued in spite of vigorous efforts to check the flow. As the dam was 42 feet high, the rush of water did great damage to property on the river below.

The action of a considerable body of water falling unimpeded over a high dam is very powerful, and most careful construction is called for, at the base of the dam and in the apron, to resist its shock and prevent the wearing away of the bottom immediately in front, and the undermining of the dam. Sometimes the fall is broken up by a series of steps; sometimes such an inclination or curvature is given to the face as to turn the falling water away and cause its energy to be harmlessly expended in rushing down stream. The vibration caused by the water of the Connecticut river falling over the dam at Holyoke, Mass., and striking the bed-rock, is felt for quite a distance.

Springs under reservoir embankments, when not led away by tight drains, have caused breaking away of the bank.

Water Pipes.—Pipes for water supply, running full, where the flow may from any cause be suddenly checked, must be made strong enough to resist, in addition to the static pressure, the dynamic effect of water ram or shock from arrest of motion. Leaks at joints, or cracks in water-pipes are of not infrequent occurrence. They are not easily detected unless large. In some cases the water finds its way to the surface, making a hole in the street; in others it flows away by the sewer and sometimes undermines the pipe, causing sagging and complete rupture of the pipe, followed by the eruption of a large volume of water at the street surface.

Water escaping under much pressure from a small hole, and conveying sediment, or coming in contact with sand and grit, acts like the sand blast, and wears away rapidly whatever is opposed to it. At the Quebec Water Works, a cast-iron pipe 18 inches in diameter and 1¼ inches thick was carried under St. Charles River, and laid in a narrow box of sheet piling filled in with blue clay, five feet below low water. A pipe leaked from a portion of a lead joint having blown out, and there was a hole 1½ inches in diameter worn in the spigot end of the pipe at that joint. The jet from this hole, under a pressure of 492 feet, or 208 pounds on the square inch, had cut three inches into the woodwork of the box, and nearly through a 7-inch post. The pipe was repaired by banding with a wrought-iron sleeve 1 inch thick and 4½ inches broad, in two halves bolted together, leaded and calked. The leak broke out again, and within a year the jet had cut a hole through the sleeve two inches wide. The defective pipe was then cut out and replaced.

As an instance of the effect produced by water where it proves too strong for the containing vessel, I will cite the case of a steel water-tank at Cincinnati, which burst on June 29, 1881. This tank was circular, 1606 feet in diameter, 40 feet high, on a masonry base, and had a

capacity when full of 2,700,000 gallons. It burst when containing 2,242,000 gallons. Rupture took place in the side, at a point 12 feet above the bottom; a hole was torn out 48 feet long and 24 feet wide. This piece was thrown 75 feet in one direction by the outrushing water; the tank was overturned in the opposite direction, and the torrent poured across private and public property, doing great damage. The cost of the tank alone, which was completely ruined, was $25,500.

Sewers.—In a system of sewers wise provision should be made for carrying off safely the largest possible rainfall, where the storm waters are taken away by such means. The results from the choking of a sewer of insufficient capacity may be very disastrous, inflicting great damage on property, bursting the sewer, washing the street badly, backing up into cellars, etc. Troubles of this sort not infrequently arise where a natural water-course through a town has been gradually encroached upon with the growth of the place, until public convenience and health have required its conversion into a covered sewer, making the land available for public or private uses. A storm of exceptional magnitude has in some cases shown that the water-way provided was too small, by ruining more or less of the sewer. Such a case could have been seen in St. Louis, when Mill Creek sewer, draining 6,000 acres, burst and broke down, necessitating repairs to the amount of $75,000.

Trenches and Shafts.—Water causes a great deal of trouble in excavating for sewers and in securing good foundations for them. Indeed, in all classes of excavations, its presence in any quantity calls for the employment of means to check its ingress, protect the sides from caving in, and the expense of pumping and draining. If the excavation is deep the head of water will cause streams to issue from every crevice, and planking cannot be too tightly jointed. Dry timber, swelling when wet, will close up many cracks effectively. The expense of pumping water from deep excavations is frequently burdensome. Special pumps are often necessary, as the water carries more or less mud and grit. In one case which I noticed, the influx of water in a shaft 486 feet deep, at one time amounted to upwards of 1,000 gallons per minute, and pumps were required to raise 12 cubic yards of water per minute to a height of 366 feet. The presence of water interferes in some degree with the use of explosives in excavating hard materials.

Masonry.—The top of masonry walls should be finished to shed water, and it ought to be kept out of all masonry, more especially that built with lime mortar. Water freezing in a wall will damage the work. When lodged in the cracks of stones and in the body itself of porous stones, it will, when freezing, disintegrate the stones. Hence stones with seams should be laid with the seams horizontal or on the "natural bed," so that the water which is absorbed in wet weather can readily dry out, and not set on edge as is too often the case with stone fronts which veneer, as it were, brick walls. The scaling off of the sandstone in the faces of some buildings is due to freezing of the

moisture in the stones. This disintegration is first apparent in the base courses, or where there are projections for the lodgment of water and snow, and the deterioration will continue indefinitely. A coating to keep out water has sometimes been employed, but in other cases the heroic remedy of cutting out the defective stones and supplying their places with sound ones has been found necesary. Soft bricks exposed to the weather also go to pieces in a similar way.

Arches, to the top of which water may have access, should be covered with a waterproof coating, elastic enough, in structures of large dimensions, not to crack if the arch changes form slightly.

Alternating washes of castile soap in water, and alum in water, have sometimes been satisfactorily applied to faces of brick wall which were under water, to prevent moisture from passing through. Four coats of each were, in one case, found sufficient to render hard-burned bricks impenetrable under 40 feet head of water. Masonry joints have also been calked with dry cement for the same purpose. One curious enemy of submerged cement joints was discovered in India, where the fresh water crabs found the lime useful for the formation of shell, and cleaned out the joints to some depth every season.

Tunnels.—In tunnels the quantity of water encountered may be enormous. Its presence causes a retardation of the work. Soft materials, rendered such by saturation with water, can only be tunneled with great difficulty and very slowly—while in dry materials the work may progress rapidly and with comparative ease. The lake tunnels for the City of Chicago water supply passed through fine, dry clay, where the material was simply picked out with mattocks, the heading shaped to the desired form, and the brick lining advanced without any timbering. The tunnel attempted under the Detroit River, however, was stopped by the influx of water. The difficulties encountered in pushing the tunnel from Jersey City toward New York, and in making a beginning at the New York end, through silt saturated with water, are probably known to all of you, and the Thames tunnel is another well-known instance of the enormous expense incurred in tunneling through mud. The only feasible way of prosecuting such an undertaking at all is to expose a very small surface of the material to be excavated at a time, and to keep the face and sides of the heading firmly in place. Heavy timbering or other temporary support will be called for, and an increased thickness of the permanent lining. Even in rock tunnels great quantities of water may be encountered. The Sutro tunnel, nearly four miles long, having as one great object the drainage of the Savage and Comstock mines without an excessive amount of pumping, had before completion a daily average flow from its mouth of 1,285,000 gallons.

Foundations.—In putting down open or submerged foundations a constant watch is required that the water does not prevent sound construction. Nine arches of the South Street bridge, Philadelphia, fell as the result of settlement of the end of one pier, probably due to

a stratum or wedge of mud which was afterwards found to underlie the pile foundation at the end which failed. The loss was $100,000. An engineer wrote subsequently—soundings with an iron rod were taken all over this ground before any work was commenced. Want of money for such a purpose, and *the presence of water everywhere*, prevented more elaborate investigation ; a fatal economy as it has proved.

Coffer-dams and caissons are not made reasonably tight under a considerable head of water without careful work. My paper has already reached such a length that I cannot occupy more time by enlarging on different examples of this class. I will refer only to the foundations of the dry dock at the Brooklyn Navy-yard,—a dock which, in dimensions and workmanship, is one of the finest in the world. "Owing to the nature of the soil selected for its site, the excavation for the foundation was attended with many obstacles, and afforded opportunity for the display of great engineering skill. The lower soil was an almost impalpable quicksand, becoming semi-fluid when saturated with water; and, before the required level for the foundation had been reached, springs coming from a great depth burst up through the bottom, rendering necessary measures to restrain the movement of the sand. This was finally done by driving piles into the cavities formed by the springs, on which a flooring of plank was laid ; upon this bricks were laid in hydraulic cement, and upon the brick floor concrete masonry; the whole being done with the greatest despatch ; vent-holes for the water were left until the permanent foundations were completed, but in this manner the flow of sand was checked." The floor, from 4 to 6 feet in depth, is an inverted arch. The masonry foundations are 400 feet in length and 120 feet in breadth.

In many cases the difficulties arising from the presence of water can be best overcome by working on a small area at a time. The forces to be coped with are then more moderate, and we have the advantage of defeating the enemy by strategy and in detachments, rather than by brute force and in mass.

Lake and Marine Construction. -An engineer who has had anything to do with construction and improvement on the sea or lake shore has a wholesome respect for the power of the waves. If one considers the energy which the mass of water in a large wave must possess, he will realize the shock to which any structure is exposed by the direct impact of such a mass, and he will see how it is possible that heavy blocks of masonry, bolted and fastened together, massive timber cribwork, lines of close piling and other constructions may be thrown out of line and removed bodily by the waves arising under a heavy storm. Wick Breakwater, on the coast of England, furnishes a remarkable case in point. The height of waves here, several times measured and estimated, was about 42 feet from hollow to crest. Stones of eight and ten tons weight were, by these waves, carried from the parapet, and it was finally determined to construct the outer end of the breakwater by depositing three courses of 100-ton blocks of stone on the rubble base, as

a foundation for three courses of large, flat stones, surmounted by a monolith of cemented rubble built on the spot. The end of the breakwater, therefore, was in substance a monolith weighing upward of 800 tons, being about 26 feet by 45 feet, and not less than 11 feet in solid thickness, cemented to the underlying rubble base. This large mass was actually seen by the resident engineer to be bodily slewed round by successive blows of the waves until it was finally removed and deposited inside the pier. Not only the upper portion, but the three lower courses of stone, forming a mass of 1,350 tons, were removed without breaking.

It will manifestly be better, where possible, to meet the onset of the waves obliquely rather than squarely. The undertow, also, washes away material from the front of a wall in some cases and causes its fall. Any construction extending from the shore into the water where a current exists will be likely to interfere with the previous condition of things so as to cause scour in some places and shoaling in others. This subject is too great to be enlarged upon now. The whole matter of the stability and improvement of water channels, including shore protection and improvement, calls for the most careful study of the locality for a considerable distance, and the effect of certain proposed changes is even then left in much uncertainty.

While I have not exhausted my subject, I may have taxed your patience sufficiently; I have endeavored to suggest some of the many ways in which water becomes a source of engineering difficulty, and to show that the constructor must be constantly on his guard against its encroachment and the resulting damage, decay and loss. Were it not for the presence of this element many plans would be far easier of accomplishment; but we should not unduly complain, for, were things otherwise, our patrons might consider themselves quite able to build for themselves and dispense with our services.

COMMON ROADS.

BY BURTON KENT, OF ADRIAN, MICHIGAN.

The construction and maintenance of the roads of a people are among the most important features of their political economy. They are the medium through which circulate all the products of their industry and elements of wealth. They are the out-growth of a necessity *coeval* with the history of man, and their improvement has kept pace with his progressive numbers, wealth and civilization. The common roads are the small veins and arteries of the body politic which *radiate* through the system and are the medium of that healthy circulation between the extremities and the vital parts without which it must languish and decay. Railroads take the place of those more important mediums of circulation, relieving the vital organs of that surfeit which must otherwise clog and paralyze the system.

The perfection and durability of the roads of the ancient Greeks and Romans have been the wonder and admiration of the world for ages, and they marked an important era in the history of their wealth and military prowess. Common roads are the highways of the mass of the people, and should be so projected and constructed as to afford the best possible facilities for commercial and social intercourse.

Alignment.—All leading thoroughfares, connecting important business centers and well-populated districts, should be as direct as the topographical features of the county will permit, regardless of that blind cupidity, which like an incubus settles down upon some communities, and paralyzes or turns back all efforts at improvement, and which should never be allowed to interfere with the location of an important line of road. It has often bid defiance to some of the most plain and simple laws of science and economy. It has ignored Hogarth's "line of beauty" and decreed that all deviation from a straight line shall be by right angles, and that all roads shall follow *section lines*, like Milton's fiend: "o'er bog or steep, through strait, rough, dense or rare," never seeming to care how much easier it may be to go around a hill or bog, than over it, nor how much longer are the base and perpendicular of a triangle than is the hypothenuse.

I am aware that, in a State where the land is all laid out in square sections by lines ranging with the cardinal points, the temptation to adopt them as road lines is well nigh irresistible, especially in communities where the passion for so doing, and for preserving unimpaired the integrity of farms and fields, has been so long nourished and petted that it has become part of the moral code of the inhabi-

tants; the people have never appreciated the heavy tax levied upon their energies by their loyalty to this popular hobby. Suppose a farmer to be so situated that he must cross diagonally a township six miles square every time he goes to market, or to his center of business or post-office; by following the zig-zag course of the section lines he must travel seven extra miles every time he makes a round trip. If it is made but once each week for one year, he must travel 364 miles more than would be necessary on a straight line; at four miles an hour, this extra travel would take him 9.1 days; and, allowing each day with his team to be worth three dollars, it will have cost him $27.30 a year. Multiply this amount by the twenty-five years that he may reasonably be expected to travel this route, and we see that he will have traveled 9,100 miles, and will have spent 227½ days at a cost of $682.50. Add to this sum the value of twenty-eight acres of land needed for the extra three and one-half miles of road, with the cost of making and keeping it in repair for this length of time, and we gain some idea of the enormous waste of time, money and vital energy for the gratification of this popular whim.

Continuous roads should never have sharp angles, but all deviations from a straight line should be made by curves or a series of slight angles, which tend less to increase its length. A road may often wind round a hill, without being much longer than the line that would pass over it, and this detour will generally be found advisable to preserve a uniform grade; for the greater possible speed on a level road will often more than offset the extra length of the line on the curve. A team will pass around a hill with greater ease than over it, and the force that will carry a given load over the hill will move a much heavier load around it, thus largely increasing the road's utility for commercial purposes.

Grade.—It is well known that a horse can carry no more produce to market than he can draw up the steepest hill on the route. Therefore the grade of the road is of vastly more importance than its length, and should enter largely into the considerations governing its location. The grade of a good road should never exceed the angle of repose; that is, it should never be so steep that a carriage will descend by its own weight, on a tolerably hard and smooth surface. This inclination, according to the experiments of Macneil, was found to be one foot rise in 30 or 35 feet horizontal; on a less perfect surface it was found to range from one foot in 20 to one in 30. The charter of some turnpike roads has limited the slope to one in ten, one in eleven and to one foot rise to sixteen feet horizontal,—a grade that ought to satisfy the most fastidious road maker. Just how much a line may be elongated to secure a grade that will balance its additional length is an intricate problem, to be solved only approximately.

The height of a hill is of much less importance than the slope adopted in its ascent; consequently all efforts to improve a hill should be diverted toward the reduction of the slope rather than of its per-

pendicular height. The horse which can draw one ton on a level road can move but three-fourths of that weight up an incline of one foot in forty; but one-half a ton up one foot in twenty-four; and only one-fourth of it up one foot in ten feet horizontal. (*Parnell's Experiments on English Roads*).

Location.—The alignment of the road; the ease of its grade or slope; the cost of construction, including cost of land, grading and bridging; the character and amount of travel to come upon it; and the needs of the inhabitants along the route, are elements to be considered and weighed in determining the final location of the road. When the points to be connected have been decided upon, a hasty examination by the eye, without instruments, of the region through which the road is to pass, will be an important aid in determining what trial lines it will be wise to run. If the country is plane, with no deep ravines and large streams, a straight line will meet all the conditions of a perfect road-line; but, if the country is rough and broken, two or more trial lines should be run, levels taken, and profiles drawn, a careful comparison of which will be necessary to aid in the final location upon the most practicable line.

Width of Roadway.—The width of the roadway in this State is fixed by statute at sixty-six feet between the fences, but the width of that portion fitted for travel is left to be determined by other considerations. For the carriage way of our most frequented roads—except near the large cities where there is much light driving and broader roads are desirable—a width of thirty or thirty-five feet will be found ample. For cross roads and those of less importance a breadth of sixteen to twenty feet will be found sufficient. All unnecessary width should be avoided, as it is not only a waste of land but it largely increases the cost of construction and annual repairs.

The roadways of Europe and the older portion of our own country seldom exceed twenty feet in width. Paved and broken stone roads seldom have this width, and the old Roman roads were much narrower, twelve feet being the usual width on straight lines.

Cross-section.—The convexity of the road surface, or the profile of its cross-section, is a feature too often lost sight of by road makers, wide roads being left too flat to shed the water, and narrow ones too convex for the safety and convenience of travel. The surface of all roads should be sufficiently convex to readily turn off the water before it has time to soak into the surface, and convert it into mud.

The shape usually recommended for the transverse section of the road is a curve approximating the segment of a circle, or better a semi-ellipse. Some prefer two inclined planes, sloping both ways from the center to the side drains.

Drainage.—In forming a road bed in a flat country the first and most important feature to provide for is its thorough drainage, without which no very good results need be looked for, but with which a very

bad road will often be converted into a good one. Good and sufficient side drains should be provided to readily take the water from the road bed, and the adjoining lands. These drains should be at least two and one-half feet deep below the surface of the road bed, and should have a constant descent to the natural water-course of the neighborhood, so that no water can remain in them to soak into the sub-stratum of the road. When springs occur under the road-bed, as is often the case on side hills and in excavations, cross-drains will be necessary to carry the water to the side ditches. On side hills these drains may be laid diagonally with the line of the road, meeting in the center in the form of a V, with the point up hill, and should be put as low as the side drains will allow. Similar results may be often obtained by one or more longitudinal drains laid parallel with the axis of the road, connecting by occasional cross-drains with the side ditches.

Culverts—Must be provided for small streams intersected by the road and also to carry water from the side ditches on the upper to the lower side of the road. These drains should be of sufficient capacity to meet all demands and should have a descent, when practicable, in the direction of the current sufficient to prevent deposits of mud.

Bridges.—Substantial bridges for small streams may be constructed by building abutment walls of field stone where they abound, laid up dry, using cross-stringers, and covering with plank. Where stone abounds, bridges of fifteen to twenty feet span are often built in this way. For long-span bridges some of the modern improved forms of superstructure will be found well adapted to the needs of the varied situations. The forms of combination bridges, with iron lower chord and suspension rods, for common roads, are deserving of the careful consideration of those entrusted with these improvements. Wooden bridges are fast losing their prestige, owing to the inferiority of wood for tensile members. As the combination bridge is of but one-half the cost of an iron one; as it will last, if properly cared for, twice as long as a wooden one or even longer; and as when the wooden members fail they may be replaced at little cost, the combination type is fast coming into use for highway purposes. Since bridges are an important item in the cost of maintaining roads in neighborhoods where there are large streams to cross, no pains should be spared to select the best. If the commissioner should be unable to analyse the strains of any given form of bridge, he should employ a competent person to do it for him, before deciding upon its merits and adopting it.

Earthwork.—The stone, wooden and iron constructions on a road are generally built by skilled workmen, but the earthwork is usually entrusted to any one who will undertake it. When a road bed is to be raised by material from the side ditches, the turf and surface soil should be rejected, or, if used, should be placed at the bottom of the embankment, disposed uniformly over the foundation, and covered

with material from the subsoil, or, better, from some neighboring excavation. No vegetable mould or muck should ever be allowed to come upon the surface of either a new or an old road; for when decayed it absorbs the water and makes the softest mud. In forming embankments the material should be applied in uniform layers, each being separately packed as the work progresses. When the road is completed and opened to travel, or when new material is added to an old road, great vigilance is required to prevent the formation of ruts and holes, all of which should be filled as fast as they appear by raking in the loose material, picking off the hard knolls and keeping the surface smooth and even. If the road is to farther improved by the application of a covering of gravel (which will be the extent of the improvement of our common roads for a long time to come), it should then be applied in two or three layers of four to six inches each, uniformly applied and separately packed, either by a heavy roller or by the ordinary travel on the road; and the same vigilance should be exercised in preventing the formation of ruts and holes for the collection of water.

As a superabundance of water is the most persistent foe of good roads, the roadmaster will use every effort to totally rout and drive it from the field, leaving no lurking place or rallying point. Therefore, a thorough system of drainage should be re-enforced by the unobstructed rays of the sun and free circulation of the wind, so essential to dry and harden the surface. The much lauded practice of planting continuous rows of trees along the margin of a road is one to be discouraged, as they deprive the road of these beneficial influences. A few trees may be tolerated, but they should be at least six or eight rods apart.

The features that most characterize a good road are smoothness and hardness, and all efforts in the right direction, either in construction or repairs, will tend to secure these conditions; and the system that will maintain them with the greatest degree of uniformity and with the least expenditure of time and money, is the one that prudence and economy will suggest and adopt.

Defects of the Present System.—The most glaring defects of the system quite generally in vogue with us are:

First:—The standard practice of periodical repairs, made but once in a year, suffering the road to become nearly or quite impassible before anything is done to repair it.

Second:—The universal practice of rotation in the offices of Overseer and Commissioner of Highways, who often enter upon their duties with no other qualification than that conferred by their election. The little skill gained by one year's experience is lost by the change, and the successor enters upon his term of experiment and failure at the expense of the roads and those who travel them.

Third:—The system, universal in this country, of maintaining roads by a labor tax and personal service; a plan that has crept down to us,

through the misty past, from the barbarism of the feudal ages, and more suited to a feudal lord than to this free age of the American Republic.

This barbarous practice is rendered doubly ridiculous by the loose and slovenly manner of its enforcement. The adoption of some more judicious and better regulated system of maintaining the common roads of the country is most imperatively demanded, and would work an important degree of progress in our social intercourse and habits.

Prof. Gillespie wrote, "The roads of a country are accurate and certain tests of its civilization." Dewitt Clinton said, "Every judicious improvement in the establishment of roads and bridges increases the value of lands, enhances the price of commodities and augments the public wealth."

Remedies.—Interests of so much consequence to the prosperity of a people should never be left to the tender mercies of a slothful overseer or to the cupidity of neighborhoods and towns.

All important roads, extending through several townships, should, with their bridges, be made wards of the county; or they should be maintained independently by a tax upon the lands adjacent to and benefited thereby. We construct a ditch or sewer and tax the cost by the principle of benefits; why should not the same plan be pursued in the case of roads? To compel towns near an important market to support roads leading far into the country, and affording a thoroughfare for the concentrated traffic of several remote towns, as they often do, is a gross injustice. Place all the principal roads under the charge of the county, and skillful supervision can be more profitably employed for their support.

Road-making has long since attained the dignity of a science, and none but persons of knowledge and experience should be intrusted with their maintainance. The first step in the improvement of the present system of road repairs is to employ a person of skill, integrity and energy, to take charge of and superintend those repairs. A county should employ a competent engineer, who should be empowered to lay out, alter and discontinue all roads (under suitable restrictions), and who should superintend all road construction and repairs. He could appoint a deputy or assistant in each town if necessary, who could farm out the work by job, or could superintend its performance, according to the plans and directions of the engineer, and watch all the details, as the work progresses. The repairs should be the work of the season, a careful supervision being constantly kept over the whole system, and repairs made as often as they are required. The expense incurred for service and material should be paid out of the funds of the county, raised for the purpose in the same manner that other county funds are raised. Then every tax payer would be a self-constituted vigilance committee to supervise the work.

Some of the States have already adopted a portion of these reforms,

with others that might be mentioned, with such beneficial results that they are now wondering why it was not done long before. Legislation upon the subject has become an imperative necessity, and the prompt attention and action of every State are emphatically demanded.

DISCUSSION.

MR. G. E. STEELE.—Through custom, engineers and surveyors have had little to do with highways; but the reverse should be true. In one instance, to my knowledge, a bad location cost a great deal of labor. Another instance was seen in the construction of a macadamized road near Traverse City. The most of the road consists of clay and gravel combined, laid on a foundation of stones; of necessity, a portion was built of gravel and clay on sand, and that part has proved the best of the whole.

MR. H. D. BARTHOLEMEW.—An old saying is applicable to roads—"Make them dry." I believe our roads would be much improved, if we would use improved machinery for making roads.

MR. F. HODGMAN.—The first thing to be done is to wake up the people to the condition of the roads. A road near Kalamazoo goes over a hill, which it might as well have passed around, and thus costs the people $5,000 a year more than necessary. The law provides that the Highway Commissioner may have grade-stakes set; it would be interesting to know if they have done so in a single instance. The law is in advance of practice.

MR. E. F. GUILD.—Mr. Hodgman has struck the key-note. The value of time lost on the roads would more than pay for good roads built under competent supervision. We must teach the people how to make good roads.

MR. S. N. BEDEN.—In one instance I secured an excellent piece of road, which had before been very wet, by building an under-drain below the centre of the road.

MR. H. G. ROTHWELL.—Roads are usually turnpiked in such a manner that the side ditches have no outlet, and the centre is lower than the edges, forming simply an elevated ditch.

MR. F. M. PRIEST.—In Ohio, roads often have a flat surface, sometimes improved by a covering of gravel; but it would be better to make the surface convex before putting on the gravel. It is not right to repair holes in a gravel road by dumping in a load of gravel; such practice is likely to make two holes in place of one.

MR. M. W. BULLOCK.—The tendency is rather to straighten roads than to make them more crooked. The same charges are made against the Highway Commissioner as against the County Surveyor. Would you apply the same remedy—abolish the office?

MR. B. KENT.—It would be desirable in some instances. The great evil of our road system is the practice of keeping the roads on section lines. It is doubtful whether a rut in a gravel road can ever be well mended by the use of gravel. One should use some softer material, as a mixture of clay and sand.

DIFFICULTIES IN CITY SURVEYING.

BY A. J. TEED, OF CADILLAC.

I will call your attention to some of the difficulties in city surveying which I have met with during the last four years. I do not expect so much to instruct any one as to awaken discussion and call out the experiences of members of the profession on a subject hitherto almost entirely neglected in our meetings.

Original Survey.—The town where I now reside was surveyed about twelve years ago with a common compass and chain. The work was done about as accurately as woods work generally is, that is, most of the angles were within a quarterof a degree of the values given on the plat, and very few stakes were more than a rod from where we should expect to find them.

The surveys in the town, for about eight years following, were made by a man who had good instruments and could do good work if he wished to. As the old stakes were nearly all standing, he was not very frequently called upon, but, when he was, he sometimes followed the original survey and sometimes not, so that very little was done towards rectifying the irregularities of the first survey. He then left the place and I was called upon to run lines.

I was very desirous of making such surveys that, in case of litigation, they would be sustained by the courts, and that at any subsequent time I could make a re-survey in the same place. This task was not an easy one, as there was no record on paper of any previous surveys to be found. There were stakes in the ground, but whether they were set for the corners of lots or for the ends of wood piles was hard to tell. There were fence posts and buildings, but whether they were set by a surveyor or by guess none could tell. In fact there was *nothing* that could be depended upon by which one might begin or end a survey. Yet the town was growing rapidly, we already had about 3,000 inhabitants, business was on the boom, and soon we expected to exceed the great city of Chicago.

Correction of Errors.—At first I determined to hunt out the original stakes and make all my surveys correspond with them. Where a corner could be found I would retain and perpetuate it; when they were lost, I would set my stakes at proportional distances between the nearest known corners, on the principle of the government survey. I would agree with the courts, if not with any one else. I was not responsible for crooked lines and I would teach surveyors and the public generally the importance of having work done right the first time. To this plan I faithfully adhered for some time; but difficulties

innumerable surrounded me, difficulties even more embarrassing than to disagree with the courts. It was frequently impossible to tell whether a particular stake belonged to the original survey or not; the only thing that could be told was that the original survey was irregular and incorrect.

To increase the difficulties of this method I was called upon to make numerous large additions, the streets of which on the map corresponded with those on the original plat. The question now was —should the streets in the additions be laid to fit the streets in the original, or should the streets in the original be shifted over to fit those in the additions? In this case, as the additions were the larger, they were laid out as accurately as possible without regard to their connection with the original streets.

I next set about the task of ascertaining what changes would be necessary to make the old streets fit the new. I found the difficulties in most cases much less than I had anticipated. In fact people were generally more willing to accept the corners of an accurate survey according to the conditions of the *plat* than they were the stakes of the original survey.

I have at length come to the belief that it is a great mistake, in young and growing towns, for surveyors to undertake to perpetuate the inaccuracies of former surveys. Of course where a party has possession of the land, has built his fences and buildings by the original surveys, and to move would be a damage, the surveyor has no choice in the matter. In a majority of cases, however, where parties desire to have their lines established so that they will not be called upon to move, it is better to drive the stakes where they should have been driven the first time, whether they were or not. This method, instead of being productive of trouble and litigation, is the reverse. Definite and permanent boundaries are desired. If we can once persuade land owners, for we cannot compel them, to adopt an accurate survey, all trouble is ended, which is not the case when we undertake to adhere to what may be a legal but irregular survey. Landmarks are soon lost; surveyors and others who knew where the corners were, pass away; disputes arise and new surveyors are called upon to settle them. They are compelled to fix the bounds, not according to their chain, but according to their judgment. Judgments like watches do not always agree, and, at last, after great expense, the boundaries are established, not by surveyors but by the courts. Of course in old towns where lines have become fixed by time, very little can be done; but in young and prosperous cities, where most of the surveying is done by one man, very much can be effected towards correcting the errors of former surveys, thus laying such a foundation that, in future years, a correct survey will depend not on the memory but on the skill of the surveyor.

These remarks lead to a second class of difficulties. No one should assume to correct the work of others or set himself up as a model for

others to follow unless he is sure that he is right. Good work cannot be done without good tools. Such tools are easily obtained; but with the best of tools good results cannot be secured without great labor and patience. The greatest errors with which I have met and those most often disregarded arise from a change of temperature and a change of elevation.

Change of Temperature.—One who has not tried it would be greatly surprised to find how great a difference is made by a slight change in temperature. I discovered one day that I could not obtain the same results on different sides of the street, and, after measuring the line over repeatedly, to be sure that there was no error in the work, I discovered that the two and one-half inches difference in length of the line was caused by one side being in the sun and the other in the shade. The expansion of steel amounts, in a distance of 1,250 feet, to about one inch for each 10° change in temperature. A line of that length, measured when the tape is heated to 100°, a not uncommon temperature, and then measured again when the temperature is down to 40°, would show a difference of six inches, a variation altogether unallowable in city practice. The most convenient remedy in this case I have found to be, to carefully put down a monument as often as each 1,000 feet. Whenever a point is required between two monuments I measure the distance clear through and divide the difference. By this means one can always get the same results without regard to temperature or the correctness of the chain.

Measuring on a Slope.—I have experienced great difficulty in obtaining correct measurements in chaining over hills. It will not do to trust to the eye in leveling the tape. Some of our streets are on a long incline facing the lake. I found that by putting my eye to the ground and sighting along the tape to the woods on the opposite side of the lake, a distance of about three miles, I could readily level the tape to within about three inches; by this means I was able to measure a distance of 400 or 500 feet down hill and not vary more than one-fourth of an inch, when, by leveling the tape with my eye, I could not get the same results within two or three inches.

In conclusion, I would repeat what experience has taught me to be the best policy in new and growing towns, when but a small part of the surveyed town is occupied. Use good instruments; do all work with care and precision; prove every line, and then, whenever possible, plant your corner where it should have been the first time. But when, from previous occupation or other cause, this cannot be done, I would carefully line up the streets, get them in the best condition possible, and then make them permanent by monuments and records. This method, though somewhat arbitrary, and one in the results of which contemporaneous surveyors might not always agree, yet, if faithfully followed by one man for a number of years, will very much simplify the labor of future surveys. It will kill seeds of litigation and will be of great advantage to the public generally; for, when the

irregular surveys are once abandoned and the correct ones adopted, they will never again be called upon to make a change.

DISCUSSION.

MR. H. G. ROTHWELL.—In East Saginaw, a monument of cast iron, with a hole in it, is set by order of the city at the intersection of each block, as nearly according to the plat as can be determined. Private notes and reference points are taken. The practice has been very advantageous in producing uniform surveys. The Sewer Engineer disturbs them and only the private notes will show whether they are properly restored. Some permanent system of monuments and records is needed.

MR. S. N. BEDEN.—The surveyor may, in many cases, induce parties to agree on correction of errors of original survey, even if courts might decide otherwise in cases of litigation.

MR. B. KENT.—What shall be done with a surplus of land between two plats in the same block, made at different times on the two parts of the block, and where there are no metes and bounds?

M. F. HODGMAN.—The statement shows that there is no evidence to determine the lines of the lots nearer than the streets on opposite sides of the block; in such a case the street lines must govern and the surplus be divided pro rata between the lots.

MR. E. F. GUILD.—In a similar case, in East Saginaw, the decision of the Supreme Court was that each part should be considered by itself.

LOGGING RAILROADS.

BY E. F. GUILD, OF EAST SAGINAW.

When there was little snow and very little cold weather during the winter, very few logs, from which to manufacture lumber, were put in the streams, and some way to transport logs during the summer was desired. As the timber in close proximity to the streams has nearly all been cut, means had to be adopted to get to market the timber that grew farther away, and could not be hauled easily or without great expense. Logging railways seemed to solve that question satisfactorily; but in Northern Michigan they are, with some exceptions, very crudely built.

There are several kinds: "Pole Roads" are so called from having poles laid down and pinned to the ground; and horses draw cars having wheels made concave to fit the poles. The cars are very heavy and cumbersome. The next are "Tram Roads." These are made of timber flatted on one or both sides, with ribbons of hard wood (mostly maple) fastened upon the timber as rails for the cars. They are improvements upon the pole roads, and work very well, except in wet weather, when the wheels slip more or less, and the rails wear away much faster than when dry; when snow falls and blocks upon the rails it is almost impossible to use the road. The next improvement is the substitution of light iron rails for wooden ones. Some use ties in place of stringers, but in low places ties are more expensive, and worse for the horses to walk over. On roads which are ironed, but one horse is used to draw the cars; on pole or tram roads two are generally used, one ahead of the other.

The next improvement is the introduction of locomotives. Where they are used we find some crude work, although the owners are doing much better since they have learned that it is cheaper to build roads well and use heavier rails than were first put down. The men who began their construction had but little knowledge of this kind of work; they had built log roads for sleds, which could be easily made to turn around a stump if it would be expensive to take it out; they had no idea of the importance of tangents and easy curves, nor much of light grades. If they had a hill in their road they would simply put a team there to double up, But experience has taught those who pay the bills that it is better to get competent men to lay out the road and superintend its construction than to leave all in the hands of inexperienced men.

Nearly all the logging roads have been laid with rails too light for their work. The builders would put down twenty pound rails and ex-

pect them to do as much work as a thirty-five or forty pound rail ought to do. The loads drawn would be as great upon each wheel as those drawn upon a standard gauge, with sixty or seventy pound iron rails, and hence the life of the rails would be short. This defect is remedied in many cases by the substitution of heavier rails and some are using steel in place of iron. Some cars have four and some eight wheels; their construction is simple. When long timber is hauled, four-wheel trucks are used, having a bolster across to hold the end of the timber, which is bound to each truck with chains, and no reach or connecting draw-bar is used. One engine (12 to 15 tons) will draw twelve to fifteen cars of long timber, with from five to eight thousand feet upon each pair of trucks, making a train fifteen hundred feet long and carrying from seventy-five to one hundred thousand feet of lumber or from 300 to 350 tons. There are thus two and one-half to three tons of paying load upon each wheel, while the weight of the trucks gives one-half ton upon each wheel. The average weight of standard gauge railroad cars is ten tons, or one and one-fourth ton to each wheel, and the load must not exceed sixteen tons, or two tons to each wheel, making three and one-fourth tons upon each wheel when loaded to full capacity, and carried on a sixty pound rail, whereas the lumber men expect twenty or thirty pound rails to carry three to three and one-half tons upon each wheel. When short logs are hauled, the load does not exceed two tons upon each wheel, and hence is not so hard upon the trucks. Much of the road is built upon stringers which will settle unevenly and cannot be kept in as good condition as when ties are used. Where the ground is uneven and there is deep filling, they pile up logs cob-house fashion, and put stringers across on which to spike the iron. This work settles irregularly unless great pains are taken in the construction.

It is not profitable to build a railroad unless there is a large tract of pine somewhat remote from water. In surveying and laying out such roads we find that the ground slopes towards the streams, in some cases for several miles, and hence the grades can be made favorable for the loads; yet occasionally they must be very heavy in order to keep the cost of construction below a certain amount. This objection is not a very serious one, unless the grades are so steep that the brakes and engine combined cannot keep the loaded cars in check when the track is slippery with water or frost, as all the loads go towards the streams, and only empty cars are returned.

The following extract from one of the Saginaw papers shows the amount of business done by some of the railroads leading to Saginaw. This statement does not include the B. R. R. R., the Wright & Ketchum R. R. in Midland county, and the Wright Lumber Co. R. R. in Roscommon county, which will add from 150 to 200 million feet, making the total between 500 and 600 million feet of pine logs and timber hauled by railroads in the eastern part of the State.

"Ten years ago the idea of hauling pine logs by rail would not

have been entertained as a profitable undertaking, but of late years it is a recognized industry. Aside from the short lines that are scattered through the forests of northern Michigan, logs are hauled in great quantities by railroads to terminal points. The Flint & Pere Marquette handles pine logs extensively, the bulk of the product coming to the Saginaw River. The Mackinaw Division of the Michigan Central has handled a large quantity of pine logs during the past two years. The Tawas & Bay County Road hauls logs to Tawas, and the Saginaw Bay & Northwestern hauls a good many logs to Saginaw Bay, which come to the Saginaw River mills.

During the month of December the Flint & Pere Marquette hauled 11,964,532 feet of logs of which 5,040,370 feet came direct to the Saginaw River. During the year 1882 this road hauled 95,294,620 feet of logs of which 46,226,419 feet came direct to the Saginaw River, and 29,932,530 feet were distributed between Midland and Averill. Of these 12,595,870 feet were manufactured at Midland and 17,336,660 feet came through the Tittabawassee Booms to Saginaw River mills. The balance of those not coming to the points named went to Manistee. The record of this road in log hauling during three years shows as follows:

	Feet.
1880	87,475,546
1881	105,296,530
1882	95,294,620

During November the Saginaw Bay & Northwestern Road hauled 5,305,781 feet, and in December 3,592,165 feet, making a total for the year of 86,039,768 feet. The Tawas & Bay County Road hauled during the year 38,486,570 feet, and the Mackinaw Division of the Michigan Central 60,000,000 feet. The aggregate for 1882 shows as follows:

	Feet.
Flint & Pere Marquette	95,294,620
Michigan Central	60,000,000
Saginaw Bay & Northwestern	86,039,768
Tawas & Bay County	38,486,570
	279,820,958

DISCUSSION.

MR. A. J. TEED.—One's professional reputation is much damaged by not remaining to oversee the construction of work which one has laid out. Some logging railroads do not use brakes.

MR. H. M. CAUKIN.—I have built a number of logging railroads; one with 30 lb. iron for Whitney and Stinchfield. I have practiced setting and marking the stakes very carefully, but have usually found that they are torn up. Some employers want the roads well built. The 30 lb. iron rails on ties two feet between centers, on Whitney and Stinchfield's railroad, were not bent perceptibly after carrying 30 million feet of logs; the engine weighed 13 tons. Knowing the weight of the engine and the steepest rising grade 80 rods or more in length, I have calculated the capacity of the engine by Trautwine's formula and found that it gave a reliable result; the actual performance would rather exceed the calculated one when the track was well laid.

I have no hesitation in putting in grades of from 80 feet to 100 feet per mile for from 500 feet to 800 feet in length on a straight line, but I have avoided rising grades on curves, when possible. The workmen deviate more from alignment than from grade, while I consider correct

alignment the more important. I use stations four rods apart; and old graders prefer them over 100 feet stations.

Whitney and Stinchfield's superintendent considered it profitable, on land cutting 20 to 40 M. feet, per acre, to build branches 80 rods rods apart when the ground would admit of it.

Mr. E. F. Guild.—All the logging roads of which I know use brakes on the cars. The engine invariably runs in the rear, so that, in case of accident, the damage may be probably confined to the cars. As to gauge—the Tawas road is 3 feet 2 inches; the Black River 3 feet 6 inches: the Wright and Ketchum 4 feet 8½ inches, and the Nestor railroad the same gauge.

PRACTICAL QUESTIONS.

ARRANGED AND ANSWERED BY I. H. LEAVENWORTH, OF SAGINAW CITY.

The Executive Committee have once more asked me to take charge of the question box. I have given such answers as seem to me to be proper; but where I have erred in judgment I hope I may be corrected so that the answers may go on record as the opinion of the convention.*

The first ten questions were submitted by F. M. Priest, of Bryan, Ohio; the two following were proposed by T. W. Pettee, of Montrose; and the last two were asked by H. I. Orwig, of Big Rapids.

1. Will it pay a county surveyor to invest in a solar attachment to a compass or transit?

Answer.—Where there is local attraction, it is necessary to have some means of determining the meridian independent of the needle; but where there is no local attraction, the needle will answer every purpose. All lines, in sub-dividing sections, must be run between points that have already been located by the deputy U. S. surveyors; and, where two points on the same line can be ascertained, the bearings of all lines on that survey can be adjusted from that one. (Adopted).

2. Can the magnetic needle be trusted to take correct bearings near or upon a railroad track?

Answer.—No.

3. Shall diurnal variation be allowed for, and the time of day at which a bearing was taken be recorded with the same?

Answer.—The diurnal variation differs so much on different days that no uniform rule can be laid down. Where you are obliged to depend wholly on the needle, the best way is to run a line through before the needle has time to change much; and never, when it can be avoided, run part of the line in the forenoon and the balance of the same line in the afternoon. (Adopted).

MR. H. M. CAUKIN.—I have taken observations on the daily variation of the magnetic needle with results as follows: The greatest diurnal variation is generally 15 minutes. The greatest I have observed was 18 minutes, and the least 6 minutes. At 6 A. M. the needle coincides with its mean direction for the place; between 7 and 8 A. M. it begins to move east and at 10 A. M. has its greatest variation to the east of its mean direction; about 11 A. M. it begins to move west, and the most rapid movement is from 15 minutes before to 15 minutes after noon. It crosses its mean position at noon, and in the afternoon the

*The answers printed are in the form assented to or modified by the Association. Questions not acted upon or ordered dropped have been omitted.

motion is reversed, the deviation becoming most westerly at 2 P. M., and the needle returning to its mean direction about 6 P. M.

The greatest difference is found in clear weather and when the air is in the condition we call bracing. The duller the weather, the less is the variation, and it is least in dull, drizzling or rainy days. At times of light thunder showers I think I have observed a disturbance of from 15 to 30 minutes, in a few minutes of time, but, as there was no regularity, I could not repeat observations so as to be certain of the amount.

4. After taking the first bearing of a line, should the surveyor be governed by the back-sights or by the needle in running the line?

Answer.—The needle can never be depended upon to do good work; it should be superceded by the transit where correct lines are required, and all angles measured by the transit. At any time thereafter, as long as two points on any one line of the survey can be ascertained, the bearing of the remaining lines can readily be located. The needle is very useful for approximate work, where great accuracy is not called for, but is liable to change from so many causes that it is impossible to guard against them. (Adopted).

5. In surveying fractional sections and establishing quarter corners in the same, should the lines be divided *pro-rata*, according to the Government notes, or should the east or south quarters be made *full* and all excess or deficiency be allowed on the west or north quarters of the fractional sections?

Answer.—Where any two points on a section line can be ascertained, the distance between them must be assumed to be exactly what the Government notes call for, and no more; if we find, by measuring it with our chain, that it is longer or shorter, we must assume, for that line, that our chain is enough too short or too long, as the case may be, to make the difference; in other words, divide the excess or deficiency *pro-rata* between the different parts into which the line is to be divided. (Adopted).

6. Should the surface (top) of a road grade be made level, as usual, or rounding?

Answer.—Make it rounding.

7. Should tile, where practicable, be laid on a regular gradient, or the greater fall be given at the commencement or outlet of the drain?

Answer.—In any stream of water, other things being equal, the larger the volume of water the faster it will run. A tile drain usually receives water along its entire course, so that it will not need any greater fall near the outlet than at any other point, if the outlet itself is kept clear. The level of the water at the outlet should, where practicable, be kept below the bottom of the tile, so that the tile will free itself from sediment, which it will not always do if the water is allowed to back up into it. (Adopted).

8. Is it best in all cases to lay the larger sized tile at the lower end of the drain?

Answer.—Where tile receives the entire amount of water at the upper end, there is no necessity for having larger tile below, as long as it has the same or greater fall per hundred feet; but where it receives much more water, or where the grade is less, so that the water will run slower, it is sometimes necessary to put in larger tile to carry off the flow. (Adopted).

9. In using eleven pins, do you give one to the rear chainman at starting?

Answer.—Yes.

10. What is the minimum amount of fall to be given an open drain per hundred feet? Also to tile drain?

Answer.—It is nearly always necessary to be governed by the general surface of the ground in establishing the grade of a drain, and no general rule can be given. I have known drains not more than 80 rods long, with no fall, where they had a good outlet, to answer a very good purpose. Of course they are more apt to clog, and, in open drains, an obstruction in the ditch at any point backs the water to the upper end the entire amount. If the ditch has ever so little fall this objection will be partly removed, and the more fall the better. (Adopted).

11. To what extent are the measurements of distances reliable between section corners on the township lines, generally called the township jog? I have some examples, on the E. and W. line between T. 8 and 9 N., R. 5 E., that I feel sure are not reliable, although another surveyor has located a corner by the given distance in the face of evidences that the corner is elsewhere. Two of the given distances on this line I know to be wrong, and hence I have less confidence in the third, where trouble is arising.

Answer.—In locating any corner, the *best* evidence should be used. Where there is no other evidence of the location of a section corner on a town line, the distance from the corresponding corner of the other town becomes proper evidence; but where the distance given is not consistent with other positive evidence, the best evidence should be used. Surveyors might differ in judgment as to weight of evidence. At the north-west corner of Sect. 3, T. 9 N., R. 1 E., the field notes call for a jog of seven links. I was there when the bearing trees of both corners were standing andlines marked plainly from each, and found the jog to be 195 links, nearly 28 times as much as the field-notes called for. (Adopted).

12. Is it proper to run a quarter line directly across a section where it would cross a Reservation line in so doing? In T. 9 and 10 N., R. 5 E., in some places the section lines make a jog, as on the town lines; at other places they coincide. The point of intersection of quarter line and Reservation line might be located by measuring

along the Reservation line, as for quarter stake on west or north side of a township, or we may run the quarter line from quarter stake to quarter stake across the Reservation line. In some places it will make a little difference. Some of the measurements on and near this Reservation line are inconsistent; in view of which fact, different methods of sub-dividing suggest themselves to a thoughtful surveyor; but the law may require the work to be so done as to appear bad and unequal. Much bad work has been done on and adjoining this Reservation, and I think it is a proper subject for consideration.

Answer.—Where there is a jog on a Reservation line, as on the west line of the Reservation in T. 10 N., R. 5 E., and still greater on Cass River along the south line of the Reservation in T. 11 N., R. 6 E., the quarter line should be run from the quarter post to the Reservation line on an intermediate bearing between the two section lines, as in the case of the lake in Question No. 13, whether it bisects the distance along the Reservation line or not. But where the section lines from both sides intersect the Reservation line at the same point, the quarter line should be run in the same way as though no Reservation line was there. (Adopted).

13. How shall the north and south quarter line and the lines dividing the north-east and north-west quarters, north and south, into eighties be run, in Sect. 20, T. 16 N., R. 8 W., where the south-east and south-west corners and the south quarter post are all in a lake? The other stakes are all standing. The bearing of the west section line is N. 1° 38′ W., and of the east section line N. 1° 10′ W.

Answer.—From the quarter post on the north line run the quarter line S. 1° 24′ E. to the lake, that bearing being intermediate between the two section lines. Establish points half way from the quarter post to each section corner, and run S. 1° 17′ E. for a sub-division of the east half, and S. 1° 31′ E. for a sub-division of the west half, or a bearing between the section lines proportional to the distance from the respective lines. (Adopted).

14. Have the majority of the members of the Association expressed an opinion that the eighth lines of a section should not be straight lines running from the eighth post on one side to the corresponding post on the opposite side, but that, after the sub-division of the section into quarters has been effected, the sub-division of the quarter sections should be performed by running straight lines from the eighth post to a point on the quarter line midway between the quarter post and the centre of the section?

Answer.—The half-section should be divided *pro rata* between the centre of the section and the quarter post, the same as on the section lines. (See proceedings of 3d meeting, 1882, pp. 51 and 53). (Adopted.)

NECESSARY INSTRUMENTS FOR SURVEYORS.

BY J. B. DAVIS, OF ANN ARBOR.

All surveyors do not need the same tools. They should accord with the work, and the following brief suggestions are based upon this conception. There are things, however, needed by all surveyors, some of which will be mentioned first.

They need the most acute perceptions; they should be able to discern the slightest sign of any fact bearing on the case in hand; a surveyor should possess very large as well as the most acute perceptive faculties.

At this point I anticipated being requested to confine my remarks to the subject. Therefore I respectfully represent that the faculties of a surveyor are his best tools. Without these he must lose not only his position, but even his identity. Conceiving that I have, by this brief argument, established myself in an unimpregnable position I hasten on.

The surveyor must possess, like a good hound, a keen scent for evidence; in other words, a magnificent nose. The first suggestion then becomes in simplest terms only this:—All surveyors should have a nose—a magnificent nose. This nose must be put into the business of a great many people, and the surveyor ought to be able to put it there without giving offence.

Another thing all surveyors need is a pair of scales. Those celebrated philosopher's scales are much like the kind desirable for surveyors. Each should have a fine pair, delicate in action, but extensive in capacity, that can take in a bulk of evidence, weigh it with precision, and give results fit to guide the business of men. All need sound judgment.

Also all ought to have exact information, considerable ingenuity, trained senses, active dispositions, good tempers, stability of purpose, adamantine integrity and the courage of a clear conscience. Then some books and a few implements—largely agricultural—with a thorough experimental knowledge of them, particularly those agricultural, will outfit one for a surveyor's pursuits; where may be won the confidence of some, the enmity of others, a little money, no fame, and the rheumatism. Of those other implements I will now speak, the agricultural first, because of their importance. Some things are the truisms of experience. These are a few. If you want a sharp axe, hatchet or grub-hoe to use, provide your own, keep them in order and carry them with you. Farmers seldom have such things. If you are particular about your axe, keep hold of it yourself or lock it up. It is less

work to teach a man to use and care for a transit than to teach him to take good care of an axe. On long trips into an uninhabited country, it has been proved by plenty of experience that, if you want anything to eat, take it with you and then you will have it. Here I may be called to order, but I insist and all the liberal eaters here will sustain me, I feel certain, on an appeal, that a surveyor is no good without his chop-sticks, or their equivalent, and material to work them on. Having, therefore, disposed of what I consider the most important part of my subject matter, I will proceed to take up something else.

With regard to books. These should be few, containing only practical statements, and be written by men of the most intelligent experience. I suggest:

Warren's Drafting Instruments,
Warren's Projection Drawing,
Instructions to Surveyors General,
Lester's Land Laws, Rulings and Decisions; 2 vols.,
Angell on Watercourses,
Judge Cooley's paper of 1881, Proceedings Mich. Assoc. S. & E.
Professor Carpenter's paper of 1882, Proceedings " " "
Henck's Field Book for Engineers, or
Searle's Field Engineering,
Chauvenet's Trigonometry,
Chauvenet's Geometry,
Chauvenet's Astronomy, 2 vols., if one is needed.

I have named no work on Surveying. I don't know of any to name in this connection. Gillespie's is still the best I suppose. This list will not be required except as new demands arise, and practice extends. Each may select what is needed. If it happens that knowledge is required in other directions, still other books may be wanted. For tunnel surveys see records of such works. For triangulations, base measuring apparatus, etc., see the various reports, particularly those of the Chief of Engineers, U. S. Army, and of the U. S. Coast Survey. The final report upon the U. S. Lake Survey is just finished.

Certain principles should govern us in the selection of books and implements. The tools should be according to the work. Tools of varied and extensive application are the best. Simple, plain, common tools are those best adapted to our wants. Special tools are of little use in a general and varied practice. Makers construct tools for a livelihood. They must sell them to live. It is natural for them to urge their sale. We must use them. Our income is from their use. Hence we should have those that work, work well, work everywhere, at all times, are always ready and never fail us. Few tools should do all our work. Few tools! Few books! Few tables! Specialties in any direction, exceptions. More aid is to be derived from improving our processes than from inventing special instruments or preparing special tables. Every instrument should be simple in manipulation, especially in the adjustments. The adjustments should be very few and easily understood.

Beginning then with instruments for use where rapidity is to control accuracy, as in the newest districts where the country is not open, I would suggest a Gurley Compass with folding sights, a three and one-half inch needle and a variation vernier. With this compass use a steel tape, home made, if necessary. This simple outfit will be found to have some capacity for work. With the vernier the needle can be read to minutes if it is a good one. Angles can then be read equally close, which be found quite as precise as the sighting can be done.

Next in order I should place Gurley's Railroad Compass and a steel tape, with the possible addition of a Buff & Berger's Dumpy Level and a home-made rod. With these tools in right hands, creditable work has been done.

Then I would say a good transit, level and rod, and steel tape. The rod and tape may still be home-made if one can be sure of the U. S. standard lengths. The form of transit must be determined by the demands to be made on it. The extras are always valuable when they answer a real want, otherwise they are not. It is no recommendation that they are nice. They should do something. Further, they should do something for the particular owner in his work. Plenty of good transits are now made. Levels likewise. A few general features may properly be mentioned. An instrument should be firmly supported by and secured to its tripod. The outcry for long centers makes tall instruments. They are unsteady. The same laws and proportions of stability apply here as well as elsewhere. A level or transit set up on high slim mountings will be as unsteady as a martin box on a pole. Broad-based, low-setting instruments are desirable. High, slim, unbraced standards or wyes must bear the same criticism in transits. Transit wyes should be three-legged when fastened to the edge of the plate. Patented devices for quick leveling and quickly connecting to and disconnecting from the tripods seem very valuable for advertising purposes, especially for use in discrediting the other firms in competition. When one thinks of it, it seems probable that the time taken to fix an instrument on its tripod ought not to require excessively early rising on the part of the surveyor who is bound to be ready in good season for his day's work. Generally, then, stick to plain instruments with well tried devices. Some instruments have a history by reason of their plain and simple, but very substantial, construction. There are the old Gambay instruments. There are some made by Würdemann, in Washington, and some by Buff & Berger, of Boston, particularly one, that I do not hesitate to declare a work of art. Then there are the Stackpole Levels, the Gurley Compasses and Chains, and the Spencer, Browning and Rust Sextants. In every case these instruments are not famous for gimcracks, but for general design and workmanship. Ingenuity was not the only talent employed in producing them. Another principle in the design of instruments is harmony. The factor of precision should be the same throughout all the parts. It is not best to put a telescope magnifying

fifty or sixty times on a minute plate, or a ten-second level on or under a minute vertical circle. None but intelligent students of the making of instruments should be trusted to design them. Choose a good maker and leave the proportions to him. Vary them not without his approval. A really valuable device is the shifting tripod cap. This was originally recommended as aiding in setting the transit over a point. This it does. But it does much more. It frees the use of the instrument from many restrictions. With this device one can easily and quickly set the transit in the line of two points in sight, either between them or outside of them. This saves many steps and often much work. One may set a transit on a line between two points so that the line from it to a third point outside of the line of the first two shall make a given angle with that line. When this angle is near ninety degrees the operation is not very tedious. These are illustrations of what is meant. There are several forms of this cap. I prefer, of those I have used, one in which the loosening of the leveling screws permits the movement of the transit. When leveling up, the instrument is made secure. Others I forget to fasten and consequently turn angles about the wrong plate.

All instruments should be ribbed and braced, with no extra metal to be carried about. The tripods should be as light as possible, but as stiff as a stick. The wood in them should grasp the brass at the cap and not the brass grasp the wood, as in many cases it does. Ground shade glasses at the verniers are a help. Silver only is fit for the graduations. Two cross-wires in place of one vertical in the transit will be found much more accurate, the rod being set in the space between them. The power of the eye to bisect a space is great, and the rod is not hidden when distant. In the level rod much improvement has been made. Use a speaking, or self-reading, rod and then read it yourself and find competent rodmen anywhere. Mark off exactly even feet on a pine stick and tack to it a piece of waste tape of the metallic grade, so-called, placing the foot marks on the tape even with those marked on the rod, and you will have the cheapest rod I know of for rough work, as cross-sectioning and the like. I have made them and ripped out the stuff in twenty minutes. No need of planing the edges. The painting of targets is commonly very bad. See Gillespie's Higher Surveying for good forms. The principle is this. The power of the eye to bisect an angle is very great. To bisect a narrow space somewhat less. To fix a coincidence considerably less still. To fix a coincidence when the cross-wire covers the mark and five times more not any certain power at all. With this idea design forms for your own targets.

Having barely touched upon a few points, I close, hoping for two things as a result of your generous attention. These are that you may be led to think, if you do not already, in the same plain way about an instrument that you do about any common matter, and that a point or two for discussion and consideration will as a consequence arise in your minds.

SURVEYING FOR RAILROADS.

BY F. HODGMAN, OF CLIMAX.

A member of this association who very thoroughly understands the theory and practice of Land Surveying was called on to do some locating for a line of railroad which it was proposed to run into his town. He got along very well with his tangents, but his curves had only half the radius he intended. They were sharper than he was and what was the matter he could not tell. The Chief Engineer of a railroad in this State was called on to locate the centre of a section. He did it by running a line half a mile south from the north quarter-post. I mention these instances, not as being in any way derogatory to the men, but to give point to the remark that it is well for the railroad surveyor to know something about the principles of land surveying, and equally well for the land surveyor to know how to run a railroad line if the occasion demands. Each is liable to be called on to use such knowledge. This paper is written principally for the benefit of the land surveyor, and will very likely contain little, if anything, but what the railroad surveyor knows all about. It will simply develop some of the notions which I have picked up from books, in the field and elsewhere.

There are many things affecting the practical work in the field, to be thought of in running a railroad line which I do not propose to discuss in this paper, but will merely indicate what some of them are, viz.:—How much money have you got to build the road with? What are its prospects for business when built? What interests of a local character, if any, have the officers of the road, or the towns along the country, in turning the line this way or that from its natural course? These questions and others like them are first to be answered. If money is plenty the Engineer will endeavor to locate the line so that it will be the best possible one to operate, and hence the cheapest in the long run. But if money is scarce he will try to locate it so that its first cost will be the least, and leave improvements for the future. To do this he will many times run around obstacles that otherwise he would have cut through. Suppose these questions to be answered, and under these modifying circumstances we wish to get the best possible line. Then shall we say: 1st. The straightest and shortest line is the best? Not necessarily. It may have a great excess of earthwork and impracticable gradients: Or 2nd. The line having the least earthwork and lightest grades is the best? Perhaps not. Its extra length and curvature may be such that the extra cost of tieing, ironing, and operating, may overbalance the saving in grading.

There is somewhere a golden mean which must be sought for, and that is seldom found on first trial. It is that line which taken as a whole is shortest, has the easiest grades, lightest curves, and smallest amount of earthwork. To find the line which combines the greatest number of these points requires careful preliminary work. All the lines which give any promise should be run and compared with each other. There is nothing in railroad building which pays so well as careful, thorough preliminary surveys, and nothing which is so liable to be hurried over and slighted. I have known 500 men to be sent out 200 miles from their base of supplies to commence grading on a line not one foot of which was located or a preliminary line run. If it had been possible, the graders would have been ahead of the surveyors. As it was, they were close upon the surveyors' heels demanding work, and work was given them. As good a location was obtained as could have been expected under the circumstances, but afterwards fifty miles of line, graded ready for the ties, was abandoned because it was cheaper to throw it away and build a new line than to iron and operate the old one. I think as a rule that railroad companies are in such haste to have their location pushed rapidly forward that they do not give their engineers time to do their best work, and that they consequently waste thousands of dollars in cost of construction, which might just as well be saved by a more careful location.

Preliminary lines are usually run as angle lines. Except in a few special cases I think it pays to run the curves as you go. It gives a more accurate basis for estimates, and should the line turn out to be what is wanted, saves nearly all the subsequent labor of final location. I have been accustomed latterly to run preliminary lines in the same manner and with the same care as final location and think that I save time by so doing.

Get as long straight lines or tangents as can be obtained consistently with other considerations. It often happens that what appears to be a saving made by running around an obstacle, is no saving at all, and that it would be cheaper, as a matter of first cost, to go through the obstacle than around it. On one occasion while I was in charge of construction, I ran a tangent of 1,100 feet in the place of a 7° reverse curve which had been run by the locating engineer for the express purpose of fitting the ground. I did this after the first line had been cross-sectioned and 3,000 yards of work done on it. Even then I saved 4,000 yards of earthwork by the change. I could give numerous instances illustrating the same point; that it does not always save in first cost to run around obstacles. Of course a man should use good judgment in selecting his tangents, and some engineers are especially strong in this line.

In laying tangents remember the grades; avoid when possible those which are adverse, and follow those which will carry the line up, or let it down as gently as possible in the direction you wish to go. A transit having a gradienter attachment is of great service in an open

country in selecting the grade line that you wish to follow. I have used two varieties of gradienter, Young's and Gurley's. The former was the more accurate, the latter more convenient.

If steep grades requiring the use of extra power cannot be avoided, try to get them all in one place, and that portion as short as possible.

Having selected the tangents, the next thing is to connect them by suitable curves. There will of course be a limit to the degree of curvature to be used, and within that limit we will select the curve which will best fit the ground. Within the limits of curvature usually adopted, it does not make much practical difference whether ten degrees of curvature is used in 200 feet of line, or is distributed over 1,000 feet. The 5° curve has the greater resistance, but is the sooner passed.

An experienced locator will judge very closely by his eye through what points his curve ought to pass, and his level will tell him exactly; so that very little guess-work is needed in selecting the degree of curvature to be used. But I have known an experienced engineer to spend a day and a half on 2,000 feet of line, running various curves, to find a couple to fit the ground, when the right curves might just as well have been run at the first attempt, and the whole done in two hours. In order to develop this matter a little more plainly, let us take an example, select our curve and run it in, so far as we may do on paper. We have got our tangents chosen, have run our line to the point of intersection (which we will call the P. I.), and have marked it with hub, tack, and stake. We first get the angle of deflection which the new tangent makes with the one we have been running. This deflection is equal to the angle at the centre which is subtended by the curve or arc of a circle connecting the two tangents. We will call this angle 42° 16′. Now we wish to know what degree of curve to use. If the ground is all alike so that it will make no difference on that account, the engineer will naturally select a light curve which has its deflections in even degrees and half degrees. If however, as is usually the case, there is some particular point opposite the P. I. through which it is desirable to run the line, the procedure will be a little different. We will suppose that this point has been found, either by the eye, the level, or the gradienter, and that it has been selected on a line bisecting the angle between the two tangents. We then measure on this line the distance between the selected point and the P. I. This distance completes the data needed for determining the degree of curvature. Turn to your table and find the external secant of a 1° curve for the given angle of deflection. Divide this by the measured distance and the quotient will be the degree of curvature. Shunk and Searles both give tables of external secants and other convenient tables for field use. I prefer Shunk for the field for the reason that the volume is smaller and more portable. To make this operation a little plainer let us take our example and work it through. We found our deflection angle to be 42° 16′. We find the ground to be

near grade height at a point 103 feet from the P. I. We find the external secant of a 1° curve for that deflection to be 413.2 feet. This number divided by 103 shows that a 4° curve will pass within 1.2 feet of the desired point, in the great majority of cases near enough. We next want to find our points of beginning and end of curve, the P. C. and P. T., in other words the distance to be measured each way along the tangents from the P. I. to locate the beginning and end of the curves. To find these points, if we are disciples of Henck, we will turn to our tables and find the tangent, either natural or logarithmic as our tastes incline us, of half the intersection angle—(in this case=Tan. 21° 08′), and multiply it by the radius of the curve.

Treated by logarithms this example would appear as follows:

Log. Tangent of 21° 08′	3.176155
Log of R. of 4° curve	9.587190
Log. of semi-tangent	2.743345

indicating a distance of 553.8 feet to be measured each way from the P. I. If we do not wish to spend so much time looking out tangents and logarithms we will take our Trautwine or Shunk and turn to the table of actual tangents for a 1° curve. We find it to be, for 42° 16′, 2,214.9 feet. This divided by 4, the degree of curvature, gives the distance to be 553.8 feet, a much handier method than the other. On sharp curves this method does not give quite so close results, unless we run our curve by measures along the arc instead of on the chords.

Having the distance, before moving the transit from the P. I. we run in both the P. C. and P. T. Both points are then accurate and we save time in the long run. Now if the field is open and the curve not too long we set up the transit on the P. T. and run in the whole curve, and as far as we can see on the next tangent at a single setting of the transit. If, for any reason, we can not run in the whole curve from the P. T. we may perhaps run a part of it from the P. C., and then move up to the P. T., and run the rest of it from the P. T., using the P. I. as a backsight to check by. I always run curves in this way where practicable for two reasons: it is first, more rapid, and second, more accurate than the old way of following the curve around from the P. C. Nearly all the errors in the field work are thus eliminated.

But suppose that we do not wish to follow this plan of operations. We will take our example and follow the curve around a little more in detail. The P. C. and P. T. have been set from the P. I. We measure from the P. C. to the nearest full station back of it. Say the distance is 70 feet, making the P. C. at Sta. 106 +70. Our first deflection will be for the remaining 30 feet which go to make the full station. Right here is the point where our friend the land surveyor stumbled. The degree of curvature is named from the number of degrees in the arc of the circle, which is intercepted by a chord of 100 feet; but the angle from the tangent which determines the direction of the chord is only half as great; for a 4° curve we would, therefore, turn off only 2° from the tangent for a full station and a proportionate amount for

a less distance. As we have 30 feet to start with in our example we turn off 30-100 of 2°=36′, the deflection for Sta. 107.

For Sta. 108 the deflection would be..... 2°36′
" 109 " " ..... 4°36′
" 110 " " ..... 6°36′
" 111 " " ..... 8°36′
" 112 " " .....10°36′

If this station is as far as we can see from this point, we put down our hub and tack and move up to Sta. 112. There are now two courses we may pursue. The first, which is the easiest, it to turn off 10°36′ on the transit in the opposite direction from which we have been deflecting. Back sight on the P. C., loosen the clamp, and bring the vernier to zero, which will give us a new tangent, from which we may deflect by even degrees. The other way, which is a little more trouble, but which proves all our work a little better, is as follows:--With the instrument still clamped at 10°36′ as we last used it, back sight to the P. C. Then 10°36′ added = 21°12′ gives us the new tangent, and,

For Sta. 113 the reading will be.....23°12′
" 114 " " .....25°12′
" 115 " " .....27°12′
" 116 " " .....29°12′
" 117 " " .....31°12′

But we must now be near the end of the curve. When we set and marked out the P. T. we figured it all out in this way. There are 42° 16′ total deflection, which in decimal form is 42.266°+; each chord of 100 feet cuts off 4° of this angle; hence there must be as many 100 foot chords as 4° is contained times in 42.266 which we find to be 10.566, and this quotient is the total length of the curve.

We add the length of the curve to the number of the station at which the curve began and that gives the number of the station at which the curve ends. 10+56.6 added to 106+70 gives us 117+26.6 as the number of the station at P. T.; hence we have now to deflect for 26.6 feet or 32′ making the reading on the transit for this point 31° 44′. The field work should now prove itself by both line and measure coming out on the hub previously set for P. T. We may clinch the matter and check our work if we wish by setting up on the P. T., and, with the instrument still clamped where we last used it, back sight to Sta. 112, add 10° 32′ to the 31° 44′ (the total amount deflected on our last run) which gives 42° 16′ the total deflection of the curve. With this reading the backsight should strike the P. I. If it does not there is something wrong and the error must be hunted up. It is seldom that a curve run in this way will come out right and errors of two or three feet in the outcome of long curves are common.

I have a number of times found it a great convenience to run in a curve by starting in the middle of it. These were cases where the middle of the curve was on good ground overlooking the whole length, while the P. C. or both P. C. and P. T. were in places where it was difficult to set up a transit, or to get a sight from it when it was set up; as in deep gullies, washes or streams.

In this case the transit is set up at the P. I., and the P. C. and P. T. set. Then bisect the angle between tangents and measure off the ex-

ternal secant of the curve. In the example I have used for illustration that distance would be 103.3 ft. This gives the middle point of the curve at Sta. No. 111+98.3 and we may set up our transit there and use either of the points P. I., P. C. or P. T. for a backsight from which to run our curve.

Time may be frequently saved where the deflection is but small by running from the P. I. Suppose, for instance, the total deflection is 7° 40′. We keep our transit at the P. I. and use a 3° 50′ curve, extending 100 ft. each way from the middle. Set a stake in the middle of the curve by measuring off the external secant, in this example=3.4 ft.; then measure from that stake 100 ft. along the tangents each way for the P. C. and P. T. If we wish to set 50 foot stakes between, we can do so by deflecting from the P. I., that is with the transit at P. I. The proper numbering will be kept by measures from the preceding stations. By making these small curves either 100 or 200 ft. long we do not need to set the transit at either P. C. or P. T., so that one setting of the transit takes the place of three. In such cases only the P. I. is referenced, and no hubs are set at the other points.

It will very frequently happen in a hilly country, where the line is following the valley of some crooked stream, that it is a matter of a good deal of importance, in winding along the valley, to get the lightest possible curvature, without either running into the stream on the one side, or the hills on the other. In such cases I have sometimes found it of great assistance where there were not too many trees in the way to make a rapid topographical survey of the country, map it, and lay down the line on the map before running it on the ground. For this purpose I have run an angle line along the valley wherever it could be run the most quickly and conveniently. Then with the transit set up at convenient points along this line I take observations to all the salient points of the hill and stream that I wish to locate. In taking these observations I send a man with the level rod, who moves rapidly from point to point, setting it up at each one as he goes. The direction of each point is determined by its angle from the line; and the distance is read off on the rod, either by the micrometer or the gradienter. If taken by the micrometer, the space on the rod which is intercepted by the cross-wires gives the distance in feet, provided the wires are set so as to cover one foot at a distance of 100 feet. I prefer to have them set so as to cover one foot at a distance of 200 feet, as it doubles the range of the instrument and gives sufficiently accurate results. In this case multiply the space intercepted on the rod in one-hundredths of feet by two and the product will be the distance away. If the gradienter is used, clamp the telescope and set the horizontal wire on the target at the lower part of the rod. Make one revolution of the gradienter and take another reading. The difference in the readings in hundredths will give the distance in feet if the gradienter is so made as to traverse a space of 1 foot at a distance of 100 ft. Should the distance be so great that the rod is too short for the space intercepted—one-half or one-fourth or any other fraction of a revolution of

the gradienter may be made, and the result multiplied accordingly. Suppose, for instance, the gradienter is revolved one-fourth of a revolution, and the space on the rod was 3.425 ft. Then the distance is 1,370 ft. All the salient points in the topography can be taken in this way, as fast as a man can pass from point to point with his rod, and no more time is spent at each place than would be required to take a rod reading with the level. On one occasion I took the topography in this way for a mile along the valley of a very crooked stream, which was hemmed in by high bluffs on either side, in one forenoon, mapped it in the afternoon, and picked out my line, which I located on the ground the next forenoon. At a a subsequent time, another engineer, who worked by the cut-and-try method, spent nearly a week in the vain attempt to better the location at that point.

As to work in the field :—The levels are usually expected to be kept close to the transit, the notes worked up, and profiles made in the field from time to time as the work progresses, for the use of the locating engineer. This is especially true in cases of difficult location or where a grade line is being worked to. If the transit has a gradienter or a good vertical arc and level attachment, the necessity for making profiles in the field is very much lessened or may be dispensed with entirely.

Reverse curves should be avoided where possible, which is almost always the case. I have never in my work found a place where the location could not be made just as well without as with a reverse curve, though I have no doubt there are such places. There ought always to be a piece of tangent between curves as long as an ordinary passenger train and as much longer as can be got. A table of actual tangents for a 1° curve is very useful in making the calculations to avoid reverse curves. It is also convenient in finding the degree of curvature to use in running compound curves, connecting three or more tangents. In either case simply dividing the tangent for a 1° curve by the distance from the P. I. to the place where we wish the curve to commence will give the degree of curve to use. For instance, we wish to avoid a reverse curve. The distance from our P. T. to the next P. I. is 623 ft. The deflection angle is 32° 24′. The actual tangent of a 1° curve for that deflection angle is 1,664.7 ft. We wish to leave at least 200 ft. space between curves so we will divide 1,664.7 by 623—200=423. As soon as we perform the division, we find that a 4° curve will do what we wish and give us a few feet (7) to spare. If the deflection was the other way, and we wanted to compound the curve, we would divide 1,664.7 by 623, which shows us that a 2° 40′ curve is the one we want. The points of curve and tangent on all long curves should have reference points fixed at such places outside the line as will be least likely to be disturbed, and be convenient of access, from which to relocate the points after grading is done. On short curves it is sufficient to reference the P. I. only. The points of intersection should always be preserved in some way, as they are surer points to relocate the line from, after grading, than points of curve or tangent.

PROJECTION OF A PARALLEL OF LATITUDE.

BY H. C. PEARSONS, OF FERRYSBURG.

While the problem of the projection of a parallel of latitude is of the same importance as that of projecting a meridian, it has not been considered in any of our elementary works on surveying—not even mentioned—though like the meridian, it is an independent projection, requiring special treatment. The subject is not referred to in our Government Manual of Instructions to our public land surveyors, though they are required to project many parallels of latitude; nor does the Dominion Government say anything about it in their manual, further than to inform their surveyors what the mean deflection from the prime vertical shall be, per township, in the district of Manitoba. Outside of works professedly treating of geodesy, the few hints on this subject, given by Mr. Burt, in his Key to the Solar Compass, are the only information I know of. In consequence of this general neglect, most of our young surveyors, on attempting to run a line beyond the limits of their immediate neighborhood, are confronted with a problem they have never considered; and, as a consequence, they are brought to grief in their first efforts. It is for this class that I have taken up this question,—asking the forbearance of the older members, for being more elementary, perhaps, on some points, that they might deem necessary.

The principles underlying this question are identical with those pertaining to the projection of railroad curves; for the arc of a parallel of latitude, when developed on a plane, is the segment of a circle. But the conditions under which the case is presented necessitate a different treatment. The railroad surveyor deals with curves of a few thousand feet radius, and measures his deflection by degrees, while the projector of a parallel of latitude finds his radii some thousand *miles* in length, and his deflection angles only a few *seconds*, or possibly *minutes* of arc.

This question is generally treated by supposing the earth to be enveloped by a cone, whose axis coincides with that of the earth, and whose elements are tangent to the meridian of the earth at the parallel in question.

Let the circle A D E be a section of the earth by a meridian plane, (Fig. 1.), and let A E be a parallel of latitude, projected on this plane. Also, let the lines A B and E B be elements of the enveloping cone, lying in its intersection with the meridian plane.

On the parallel A E set off any difference of longitude, A *b*, and draw the element B *b*; then is the space embraced by the two

elements A B and B *b* and the difference of longitude A *b* a portion of the area of the enveloping cone. This area being developed on a plane, as in Fig. 2, gives us the sector A B *b*, of which the radius A B is in the plane of our initial meridian, and equal to the product of the radius of the earth at A into the cotangent of the latitude, and the arc A *b* is our difference of longitude, usually given in some unit of lineal measure, as yards, meters, or miles. *The work of the surveyor is to set out, or mark this curve on the ground.*

FIG. 1.

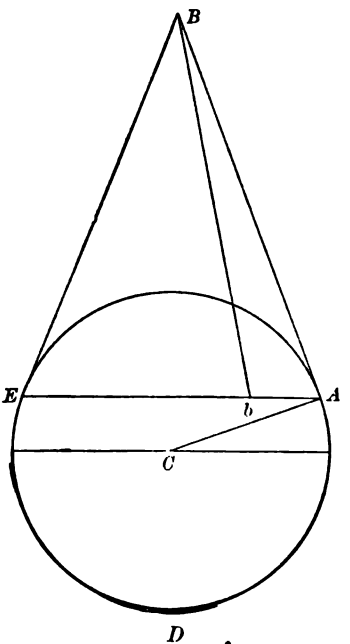
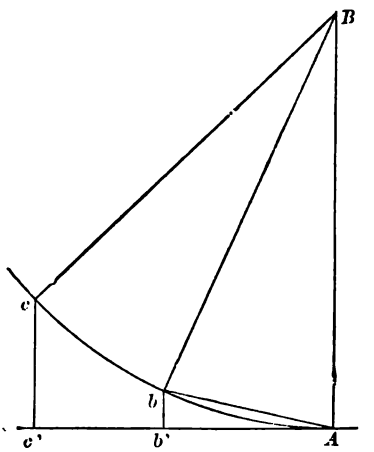


FIG. 2.



To perform this task he must know the angle *b* A *b'* for any distance A *b* (Fig. 2.) on the parallel; and he must know the law by which it varies for different distances on different parallels. The angle *b'* A *b*, between the tangent and the chord, is half the central angle at B subtended by the chord. This principle is familiar to railroad surveyors; but this central angle is the inclination of the meridians, for the given difference of longitude on the given latitude; and *it is measured by the product of the difference of longitude in arc by the sine of the latitude*, as may be easily shown. (See page 42 of Buff and Berger's Manual). This theory should be made familiar by the student, for it is the key to our solution, as we shall see.

Assuming 1° as the difference of longitude, then, the sine of the

latitude is the inclination of the meridians for 1° of longitude, in decimals of a degree on that latitude. Dividing this decimal by the number of miles in one degree of longitude on the given parallel, we have the inclination for one mile of longitude, and, multiplying by 3600, we have the same in seconds of arc.

In this manner was the accompanying table constructed, which gives the inclination of the meridian for one mile of longitude, on each parallel of latitude from 21° to 60° inclusive. From this table the surveyor knows his deflection angle from the prime vertical, when he knows his latitude, and the distance A *b* on the parallel.

Thus,—for the side of a six mile township, on latitude 43°,—the inclination for one mile, as per table, is 48″.52; whence the deflection angle from the prime vertical, towards the pole is 3×48″.52=2′26″. But here the surveyor meets with a difficulty; it is not practicable to set off odd seconds of arc, with instruments which are graduated to minutes, or possibly to half minutes. To get out of this difficulty, he must assume an inclination, or central angle, as railroad men would say, equal to *twice the smallest vernier reading* of his instrument,—say 2′ or 120″, and divide this by the inclination for one mile on the given latitude; the quotient will be the *length of the chord*, in miles and decimals, that subtends the assumed central angle; then 1′ will be the deflection from the prime vertical; and after one chord has been projected, 2′ will be the deflection between consecutive chords.

Example.—Required the length of chord, for 2′ of inclination of the meridians, on latitude 43°. The inclination for one mile on the given latitude is 48″.52 (see table). Then 120″÷48″.52=2.4732 miles=length of chord, for a deflection of 1′, from the prime vertical, or of 2′ between consecutive chords.

Mr. L. L. Nichols, in *Engineering News*, 1881, page 285, gives the following formula for this problem, in which A is the central, or "inclination" angle, "$\frac{2}{3}$" is the curvature of the earth in feet, for one mile,—and L is the latitude.

$$\frac{5280^2 \times \text{Sin. } \frac{1}{2} \text{ A}}{\frac{2}{3} \text{ Tan. L}} = \text{chord in feet.}$$

This formula gives good results; but it will be seen, that, with the help of the table of inclinations appended to this paper, the rule I have previously given is very much more simple and easy of application.

If it should be desired to set points in the parallel oftener than at the extremity of chords as above determined, it must be done by means of offsets from the prime vertical, and we shall simplify this work much by utilizing a property of the parabola, the simplest of all known curves—for, with small arcs of large radius, the parabola, near the vertex, coincides so nearly with the arc of a circle as almost to make it impossible to distinguish between them—while the property

of the parabola, by which *the offsets vary as the square of their tangents*, makes computation easy.

We must find the versed sines, $b'\ b$, $c'\ c$, etc., corresponding to the inclinations of the meridians, for the distances A b', A c', etc., and remembering that, for such small arcs as we are considering, the tangent, arc, chord, and sine are practically the same thing, we may take them indiscriminately,—the one for the other,—for we could not work to their difference if we should try.

We might multiply the distance into the sine of the deflection angle, for each offset; but it will be better to find the offset carefully for *some distance*, say ten miles—then divide this among the other points according to the *squares of their distances* from A, by the property of the parabola referred to. By computing for a point at some distance from the initial meridians, we make the parabola cut the circle at a distance *greater* than one mile, which is the usual practice, and thereby diminish the discrepancy that would otherwise result between them.

Example.—I wish to run the parallel of 43°, between two counties, for 30 miles, setting monuments at every mile—what are my offsets from the prime vertical, towards the pole?

The half inclination for 10 miles, on the given parallel, I find from the table to be 4′ 3″, the sine of which is .001178, whence, $5280\times10\times.001178=62.2$ feet. for the offset at the 10th station. Dividing this by the square of the number of the station, we have .622 feet for the offset at the first station;—and $2^2\times.622=2.49$ feet for the second station; $3^2\times.622=5.6$ feet for the third station; and $30^2\times.622=559.8$ feet for the offset at 30th station.

Unfortunately. while Congress supposed that the E. and W. lines of the Public Land Surveys were to be governed by the parallels of latitude, the Commissioner of the Land Office does not require the Deputy Surveyor to follow the *true* curve of latitude, with his "correction parallels,"—but on the contrary, he is to project randoms for correction lines, 36 to 42 miles long, accordingly as the check to be blocked out extends six or seven townships E. and W.—thus running away from the curve, in the middle of its length, some 500 or 600 feet, depending on the latitude. Thus is introduced a constantly increasing obliquity, at the section and township corners, from the middle of the check to each end, where it will be from 15′ to 20′, according to the latitude.

This obliquity is perhaps the cause of more perplexity and annoyance to the surveyor, than any other requirement laid on him;—for, if he attempts to correct it, as he will if he does not know the cause, he will make the bad matter worse.

The Manitoba surveyors project their parallels with six mile,—or rather, 489 chain chords.

TABLE:

Showing the Inclination of Meridians for one Mile of Longitude, on each degree of Latitude, from 21° to 60° inclusive.

LAT.	INCLINAT'N.	LAT.	INCLINAT'N.	LAT.	INCLINAT'N.	LAT.	INCLINAT'N.	LAT.	INCLINAT'N.
21°	19″.98	29°	28″.85	37°	39″.17	45°	52″.00	53°	1′ 08″.17
22°	21″.02	30°	30″.03	38°	40″.67	46°	53″.83	54°	1′ 11″.47
23°	22″.10	31°	31″.26	39°	42″.17	47°	55″.67	55°	1′ 14″.33
24°	23″.17	32°	32″.49	40°	43″.67	48°	57″.67	56°	1′ 17″.17
25°	24″.30	33°	33″.83	41°	45″.17	49°	59″.83	57°	1′ 20″.00
26°	25″.38	34°	35″.17	42°	46″.85	50°	1′ 02″.00	58°	1′ 22″.84
27°	26″.52	35°	36″.50	43°	48″.52	51°	1′ 04″.17	59°	1′ 26″.66
28°	27″.66	36°	37″.83	44°	50″.19	52°	1′ 06″.67	60°	1′ 30″.00

TRAVERSE SURVEYING.

BY J. B. DAVIS, OF ANN ARBOR.

The method of Traverse Surveying, with its applications, has gradually grown from the practice with the transit and similar instruments. It has been thought that its development, as taught at the University of Michigan, would interest the Association. The separate items presented are not new; no book that I am aware of contains them all; and hence it is desirable that some complete account of the processes should be given. The manner of using the instrument has, perhaps, been developed by the United States Engineers; the method of making the reductions, giving what are known in text-books as Latitudes and Departures, was prepared and taught by Prof. J. B. Henck, of the Massachusetts Institute of Technology, though not yet published, I believe. I have taken the liberty of bringing these processes together, writing them out in order, and adding a few names that seemed desirable. The old method of supplying omissions I found to be incorrect in its primary statement, and I have, therefore, prepared one which represents the actual conditions. With this introduction I will proceed at once to a detailed account.

Definitions and Conditions.—Running a traverse, or traversing, is conducting a survey in such a way that the readings of the plate will show the *angle which each line of the survey makes with any chosen reference line*, instead of the angle which each line makes with the preceding one. The former angle may be called the Traverse Angle of a line. The traverse angles will be reckoned from the reference line in right-handed rotation, through any number of degrees. Thus, if A B is the reference line, the traverse angle of B C is H B C; of C D is 360° minus the acute angle P C D. At the other points the traverse angles are indicated by the dotted arcs. The graduations of the plate will be reckoned from 0° to 360° degrees, running round to the right. The telescope will be kept the same side up during all the observations.

Directions.—Set the instrument at B. Backsight towards A with the plate verniers reading 0° and 180°. Record these readings, each in its proper column in the note book, as in the table below. Take another look at the verniers and the backsight, to see that the instrument is exactly set. Unclamp the plate-clamp and set the line of sight on B C by means of the plate-clamp, and slow-motion screw. Record the present vernier readings, each in its proper column, opposite a note in the first column showing that the sight is from B to C. Unclamp the plate and turn again on the backsight, to make sure that the plate readings are as when the plate was first set. Next move to C; backsight to B with each vernier set at the same reading as when

at B, and foresight on C. Unclamp the plates and set the line of sight on D with the plate-clamp and slow-motion screw. Record the plate readings, and then test the backsight again as before. Move to D and repeat similar operations, using first the readings last obtained at C. Proceed in this way at will, measuring and recording all the distances from point to point where the instrument is set.

SIGHTS.	VERNIER I.	VERNIER II.
B to A.	180° 00′ 00″	0° 00′ 00″
B to C.	55° 10′ 30″	235° 10′ 30″
C to D.	136° 13′ 00″	316° 13′ 00″
D to E.	259° 24′ 30″	79° 24′ 30″
etc.	etc.	etc.

If the line A B is not the reference line, set the verniers, when starting at B, so that one of them will indicate its traverse angle, and record these readings, noting which one is the traverse angle of A B. Then proceed as before.

Remarks.—These notes may be interpreted as follows: As the survey is assumed to proceed from A to B, to C, D, and so on, and as the traverse angles are reckoned to the right when one faces in the direction A B, we see very plainly that, if A to B is 0°, B to A is 180°; that, in the first line, vernier II. indicates the traverse angle of AB; in the second line, vernier I., shows the traverse angle of B C.; in the third line, vernier II. gives the traverse angle of C D; and so on, alternating from one column to the other. These angles, reckoned in the manner assumed, are the ones made by each line with the chosen reference line. It follows at once that, if the survey is continued to a close, so as to come again to the line A B, the verniers should come back to 0° and 180°. The angles are thus checked at once without computation, and with no more settings of the instrument than by any other complete process of a continuous survey. The following extract from my field notes shows a case in my practice. The distances are in feet.

DIST.	VERNIER I.	VERNIER II.	
At O 2	On S. random	O 0 of E. random	
1595.1	0°	180°	B. S. Westerly on S. random.
	92° 20′ 00″	272° 20′ 00″	F. S. Northerly on E. random.
At O 1	On E. random	O 1 of N. random	
2926.75	92° 20′ 00″	272° 20′ 00″	B. S. Southerly on E. random.
	179° 34′ 50″	359° 34′ 50″	F. S. Westerly on N. random.
At O 4	On N. random		
1821.2	179° 34′ 50″	359° 34′ 50″	B. S, Easterly on N. random.
	289° 56′ 15″	59° 56′ 15″	F. S. S. E'ly on Road random to O 1 S. random.
At O 1	On S. random.		
	239° 56′ 15″	59° 56′ 15″	B. S. N. Westerly on Road random.
	180° 0′	360° 0′	F. S. Westerly on S. random.
1290.6	From O 1 to O 2 on S. random.		

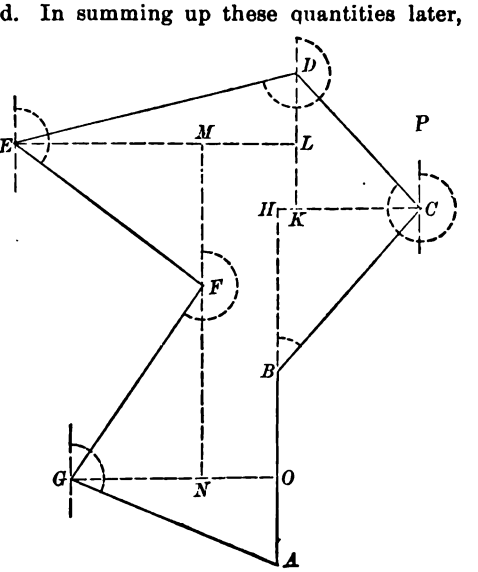
The angles in these notes close exactly, which closure is not ordinarily to be expected. The reference line is the S. random looking E., and the survey proceeds to the left. This form of notes is recommended where sights to many objects are taken from each instrument point. The angles were read with the 30″ Buff and Berger transit before you. I think it is clear that we have a very simple way of checking our angles independently, and without any calculation whatever. Two rules which should always be observed may have occurred to you by this time, viz.:

Rules.—Always keep the telescope the same side up. Set each vernier at its original reading for a line, whenever sighting along it in either direction.

There is but one set of vernier readings for each line. These simple statements describe all the field-work. Follow them mechanically, and the angles will close if the verniers are correctly read.

Next comes the office work, which consists of—1st. Proving the measurements and testing still further the accuracy of the survey; 2d. Platting the figure surveyed; 3d. Finding the areas enclosed, if desired; and 4th. Any other item of information to be derived from the notes or calculated quantities. In proceeding with this part of the work it will be necessary to compute the *traverses*, a term borrowed from navigation, and which may be defined as follows:

The traverses of a line are the two shorter sides of a right-angled triangle, of which the line is the hypothenuse, one of these sides being parallel and the other perpendicular to the assumed reference line. These traverses may be called *fore* traverses, *back* traverses, *right* or *left* traverses, according to the direction with regard to the reference line in which they extend. In summing up these quantities later, their signs must be regarded, as in algebra. Thus, if A B C D E F G A is a closed survey, A B the reference line or the one upon which the vernier readings were 0° and 180°, and lines are drawn as shown, parallel and perpendicular to A B through the points B, C, D, E, F, G,—the traverses of B C are B H, a fore traverse, and H C, a right traverse; the traverse of C D are C K, a left traverse, and K D, a fore traverse; the traverses of F G are F N, a back traverse, and N G, a left traverse.



Computation of Traverses.—From the relations of the sides of a right-angled triangle, and as seen in the Figure,

$$H\,C = B\,C \sin H\,B\,C; \quad B\,H = B\,C \cos H\,B\,C,$$
$$N\,G = F\,G \sin N\,F\,G; \quad F\,N = F\,G \cos N\,F\,G.$$

But the sine and cosine of N F G have the same numerical values as those of 180°+N F G, or the convex angle M F G, which is the traverse angle of F G. Likewise H B C is the traverse angle of B C. Therefore the traverses of a line equal the respective products of its length by the sine and cosine of its traverse angle. The algebraic signs of the sines and cosines vary according to the quadrant in which the traverse angle ends.

Between	0°	and	90°	Sine	+
"	90°	and	180°	"	+
"	180°	and	270°	"	−
"	270°	and	360°	"	−

Cosine	+
"	−
"	−
"	+

The signs must always be observed, and, since the measured lengths of the lines themselves are always positive, it appears that *fore* and *right traverses are plus, back and left traverses are minus.*

Coördinates of Points of the Survey.—If some point of the survey, as A, is chosen as the place from which to reckon, the sum of the traverses of the lines between A and any angular point will give the rectangular coördinates or distances of that point from the origin A, measured on lines parallel to the traverses. In making these summations the signs of the traverses, as explained in the last paragraph, must be strictly observed. Thus the coördinates of D from A are A H+K D and H K. Noticing that A B has no right or left traverse, since sine 0° is zero, we see that A H+K D = A B+B H+K D, or the sum of the fore traverses of A B, B C and C D. Likewise H K = H C + (−C K) or H C−C K, the *algebraic* sum of the right and left traverses of the same sides. As H C is larger than C K, H K is positive, or the point D is on the right of A. The resulting sign will indicate, in any case, where the point considered lies with reference to the origin, before, to the right, left, or back of A, on coördinates parallel and perpendicular to the original reference line A B. It will at once appear that, if the coördinates of the various points C, D, E, &c., are found in succession, one will return to A at last, and that the sum of the traverses of all the sides, or the co-ordinates of the origin after traversing the whole figure, should be zero. Hence we have a check on all the work in the field by the following simple

Rules: Find the traverses of each side by multiplying its length by the sine and cosine respectively of its traverse angle, noting the algebraic sign of the sine and cosine according to the quadrant in which each traverse angle ends.

Sum the traverses in the respective columns, as seen in the table given later, with due regard to their signs.

While this sum should be zero for the reason given above, it rarely will be, except by accident, if the survey is of much extent. If the error, or difference from zero, is small, whether plus or minus, it may be regarded as due to the unavoidable imperfections of the work, and may be distributed among the traverses according to the following

Rule for balancing traverses.—Find the total measured distance around the survey by adding the lengths of all the sides. Divide the errors in the summation of each column above referred to by the distance just obtained, and multiply each quotient by the length of any side to find the corrections for its traverses. Subtract these products from the traverses of the side, observing carefully all signs.

If all the traverses are corrected by this rule and summed, they should come very near zero. Any slight remaining difference may be subtracted, observing the signs, from the traverses of the longest sides, or from those sides, the measurement of which in the field can be most easily suspected. By these means bring the sum of the traverses actually to zero.

If, however, the angles, as obtained in the field, were exactly correct, the error in the traverses should be distributed among them in proportion to the lengths of the traverses themselves, and not in proportion to the length of the sides as directed in the last paragraph.

Small errors in the traverses originally obtained may be reasonably regarded as due to unavoidable imperfections in the field work; but if a large error remains when we have satisfied ourselves, by a careful review of the computations and a rigid inspection of their algebraic signs, that no mistake has been made in the office, it indicates with great certainty an error in the survey or field-notes. If a rude sketch of the survey is now made, with such care, however, that its parts bear a reasonable approximation to the real relations on the ground, a careful study of it with regard to the errors found will often show, more or less readily, in which side the error is. Another way is to consider what effect on the result, any of the common mistakes in chaining or in recording distances, would have. So confident have I become, from my experience, in this way of locating errors, that I once made all the reductions necessary for dividing a section into *eighties* on an assumption that a certain error existed in the chained measurement of a particular side of the preliminary survey enclosing the section. Before beginning the interior surveys, I remeasured this side and found the anticipated error. Experience in the processes of traverse surveying will soon teach one how to trace out errors, and what interpretation to put upon the figures given by the calculations.

Platting.—Having balanced the traverses as above directed, proceed to sum up consecutively the fore and back traverses, and also the right and left traverses, with due regard to algebraic signs, and beginning with the first side. The quantities in pairs, thus obtained, will be

the co-ordinates of successive angles of the survey from the origin, as previously explained. When the entire circuit is made the final quantities will be zero, thus proving the summation. We may now choose the position of our starting point or origin on a piece of paper, draw through it two lines, or axes, at right angles to each other, measure off on these lines the respective co-ordinates for any angle as above, in their proper directions positive or negative, and draw through the points thus obtained lines parallel to the axes; their intersection will be the plat of the angular point of the survey. All the points will be similarly found, and will be connected by lines, completing the plat. In making the plat of a given survey, however, certain practical considerations lead us to lay down the following

Rule.—After locating on paper any point at an angle of a survey, scale its distance from the point last platted, and see that this distance agrees sufficiently well with the length of the corresponding line of the survey. Then mark the point and join it by a straight line with the preceding point.

The angles should be taken in order round the survey, and a plat made in this way must close. It will be the most probably correct plat of the survey, as the errors are distributed according to the law of probabilities. Such a plat can be received with the utmost confidence; it will be more correct than the survey, and, if one cares to prove the field work at all, it is made in the shortest and easiest way.

Area of the Piece.—The area may be computed whether the plat is made or not. The formula for the area of a figure bounded by right lines, the co-ordinates of whose angles are known, is demonstrated in mathematical books, and I will therefore assume its truth, in order to save some space for working considerations. Prof. Henck gives four convenient formulæ for the independent calculation of the same area, and they may be expressed by the following

Rules for Area.—Multiply the right or left, or X, co-ordinate of each angle of the piece, by the algebraic sum of the fore or back traverses of the sides meeting at that angle, giving the product its proper sign. Take the algebraic sum of these products, and one-half of this sum will be the desired area.

Or—Multiply the fore or back, or Y, co-ordinate of each angle of the piece by the algebraic sum of the right or left traverses of the sides meeting at that angle, giving the product its proper sign. Take the algebraic sum of these products, and one-half of this sum will be the desired area.

Or—Multiply the fore or back traverse for each side of the piece by the algebraic sum of the right or left co-ordinates of the points at its ends, giving the product its proper sign. Take the algebraic sum of these products, and one-half of this sum will be the desired area.

Or—Multiply the right or left traverse for each side of the piece by the algebraic sum of the fore or back co-ordinates of the points at the ends, giving the product its proper sign. Take the algebraic sum of these products, and one-half of this sum will be the desired area.

These four independent computations for area give a check on our work at precisely the most important point in many cases, and where the older method of Latitudes and Departures, as given in books, left us with none. Any two of the four rules may be used; in pieces of many sides there is usually but little choice between them. In forming the products, use the full values of the co-ordinates and traverses. This will insure a perfect check.

SYMBOLICAL TABLE.

Dist.	Trav. Ang.	TRAVERSES.		CORRECTED.		CO-ORDINATES.		Double Area.	Double Area.	Double Area.	Double Area.
d	A	$s = d \sin A$	$c = d \cos A$	s	c	$x = \Sigma s$	$y = \Sigma c$				
d_1	A_1	$s_1 = d_1 \sin A_1$	$c_1 = d_1 \cos A_1$	s_1	c_1	$x_1 = s_1$	$y_1 = c_1$	$-x_1(c_1 + c_2)$	$y_1(s_1 + s_2)$	$-c_1 x_1$	$s_1 y_1$
d_2	A_2	$s_2 = d_2 \sin A_2$	$c_2 = d_2 \cos A_2$	s_2	c_2	$x_2 = x_1 + s_2$	$y_2 = y_1 + c_2$	$-x_2(c_2 + c_3)$	$y_2(s_2 + s_3)$	$-c_2(x_1 + x_2)$	$s_2(y_1 + y_2)$
d_3	A_3	$s_3 = d_3 \sin A_3$	$c_3 = d_3 \cos A_3$	s_3	c_3	$x_3 = x_2 + s_3$	$y_3 = y_2 + c_3$	$-x_3(c_3 + c_4)$	$y_3(s_3 + s_4)$	$-c_3(x_2 + x_3)$	$s_3(y_2 + y_3)$
d_4	A_4	$s_4 = d_4 \sin A_4$	$c_4 = d_4 \cos A_4$	s_4	c_4	$x_4 = x_3 + s_4$	$y_4 = y_3 + c_4$	$-x_4(c_4 + c_5)$	$y_4(s_4 + s_5)$	$-c_4(x_3 + x_4)$	$s_4(y_3 + y_4)$
Etc. to	Etc. to	Etc. to	Etc. to	Etc. to	Etc. to	Etc. to	Etc. to	Etc. to	Etc. to	Etc. to	Etc. to
d_n	A_n	$s_n = d_n \sin A_n$	$c_n = d_n \cos A_n$	s_n	c_n	$x_n = o$	$y_n = o$	$-x_{n-1}(c_{n-1} + c_n)$	$y_n(s_{n-1} + s_n)$	$-c_n x_{n-1}$	$s_n y_{n-1}$
				$\Sigma s = o$	$\Sigma c = o$						

Symbolic Representation.—The entire process of correction and determination of area as set forth above can be very briefly represented by symbols.

Let d_1, d_2, d_3, etc., be the distances or length of the successive sides, proceeding in order round the piece. Let A_1, A_2, A_3, etc., be the traverse angles of the sides of corresponding numbers. Let $s = d \sin A$, and $c = d \cos A$. Then will the preceding rules be conveniently indicated by the above table, in which Σ represents the sum of the quantities to which it is prefixed, and n is the total number of sides.

The signs given to the products in the double-area columns are those found in Henck's formulæ; if one desires simply to check the calculations, they need not be conformed to; but, if they are regarded, the resulting areas will agree in sign as well as amount. As one will naturally prepare a similar table for any given survey, it will be convenient, if the piece has many sides, to make separate columns for the plus and minus traverses of each kind, the plus and minus co-ordinates, and the plus and minus double-areas.

Practical Considerations.—Besides the abundant checks on the accuracy of all the steps of the above process and the final results, and its great simplicity when its wide range of application is considered, there are other reasons, especially in the field-work, which will commend it to us. It is seldom convenient, and often impracticable to re-run old lines along the ground in their original positions. By this process our survey lines may run within, without, or across the piece, at our convenience. We connect with the corners of the piece by lines as we have opportunity, reading angles across our own survey as often as we can, and making one closed figure, or better more, of our work. Our record shows the length and traverse angle of each line as we ran it. If we now compute their traverses, assume some convenient point as origin, and sum these traverses, we can ascertain the co-ordinates from the origin of every point needed, corners and all. Next can easily be obtained the length and direction of the straight line joining any two of the points whose co-ordinates we know, and with greater certainty than if we had measured the line and angle themselves. The operation is simply a reversal of the method by which co-ordinates are found and is embodied in the following

Rule for Length and Direction of a Line, two points of which are given by co-ordinates. Assume one point as that from which the line runs. Subtract the co-ordinates of the point thus chosen from the co-ordinates of the other, with due regard to signs. The difference of the x's will be the s of the desired line; the difference of the y's will be its c. The sign of the sine of the line's traverse angle will agree with that of s; the sign of the cosine will agree with that of c; hence the quadrant in which the traverse angle ends becomes known. The quotient of s divided by c is the tangent of the traverse angle, which can then be found in the usual tables and given that value which will bring it into the proper quadrant, as above. The length can then be found and checked by the relations

$$d = \sqrt{s^2 + c^2} = \frac{s}{\sin A} = \frac{c}{\cos A}$$

The area of a piece may also be obtained from the co-ordinates of its angles, without using the lengths of the sides, as follows:

Rule for Area by Co-ordinates Alone.—Multiply the right or left co-ordinate for each angle by the difference found by subtracting, with due regard to signs, the fore or back co-ordinate for the angle preced-

ing from that for the one following. Take the algebraic sum of these products, and one-half of this sum will be the desired area.

Or—Multiply the fore or back co-ordinate for each angle by the difference found by subtracting, with due regard to signs, the right or left co-ordinate for the angle preceding from that for the one following. Take the algebraic sum of these products, and one-half of this sum will be the desired area. Proceed in order round the piece, and pay strict attention to signs.

This rule may be represented by the following equations, where m is the number of any side or angle:

$$\text{Double area} = x_m (y_{m+1} - y_{m-1}) = y_m (x_{m-1} - x_{m-1})$$

The two values should agree. If to these equations the previous ones are added,

$$\text{Double area} = -x_m (c_m - c_{m+1}) = y_m (s_m - s_{m+1})$$
$$= c_m (x_{m-1} - x_m) = s_m (y_{m-1} + y_m)$$

we have in a concise form all the information needed. I enter them upon the inside of the cover of my note book for ready reference.

Illustrations.—I will give some examples. I was called to subdivide S. 4, T. 1 S., R. 6 E. The section is well occupied by thick tamarack and raspberry swamps, deep mud-holes and small marshy lakes. The N. ¼ P. was not set by the U. S. deputy surveyor, as is usual. There were a wagon road and open fields entirely around it. I found and restored such corners as I could, and then enclosed the section in a traversed preliminary survey, in the fall of the year. I then computed, platted it, and figured out the co-ordinates of the interior sub-division points, assuming, as before stated, that there was a certain error in a certain side of my survey. Thus I was enabled to find the direction and length of every line I needed, and where any of them produced would intersect the sides of my preliminary survey; so that I had a starting point and direction for running any interior line of the section. I returned to the work when everything was well frozen in the winter, and ran across the section in three places, the two quarter lines and the north line. No distance was less than a mile, and most of it was cut through dense undergrowth. A 30″ Buff and Berger transit and a hundred feet engineer's chain were used. In no case was the opposite stake missed by one foot, and the measurements agreed as nearly as the chain could give them.

There was considerable opposition to the method of procedure until the work was nearly done, when the rapidity with which results were reached surprised all. If randoms had been run and corrected back, the farmers saw that much additional cutting of underbrush would have been necessary.

At another time I was called to re-survey an irregular portion of the S. E. ¼ S. 30, T. 1 S., R. 5 E., bordering on the Huron river. The corners were not very satisfactory; one was down wrong, and the evi-

dences gone. The place of the meander corner on the river was under water from the building of a dam; witness trees had nearly all been cut down. Fences and fence rows were of importance here. I made a traversed survey in many directions where the ground was favorable, and located all points of interest, such as intersections of fences, etc. The disputing parties agreed upon the high-water line, and selected trees by which to designate it; these trees were located by my survey. I had three closed figures, and when I had computed and obtained the results, I could readily give all the facts with regard to the questions at issue. The time consumed, including computations and forty miles of driving, was four days, with the assistance of one man. I have, in addition, the data for answering nearly any question that may arise regarding that land. More time was spent in hunting for corners and re-establishing them than in anything else.

The point which arose, in the previous case, of the intersection of two lines, will often come up in such work. The co-ordinates of the point of intersection may be found from the co-ordinates of two points of each line, which are usually known, by the following process. I prefer it over methods given in mathematical books. Each operation is very simple, though the number of them is not as small as one might wish. A rough sketch or an accurate draft of the two intersecting lines can easily be made from the co-ordinates of the four given points, and reference to such a sketch may be of great service in following out the steps of this process, especially for the first few times. It will also aid one in selecting the co-ordinate axis for rate of approach. There are four steps: 1st. To find the rate of approach to one axis of co-ordinates for each line; 2d. To find the distance apart of the two lines at a designated place; 3d. To find the distance from this place to their intersection and thence one of the co-ordinates of this intersection; and 4th. To find the other co-ordinate of this point and to prove the work. These steps are indicated in order in the following

Rules for Intersections.—Conceive both the lines to run towards their intersection; call the given points *from which* the lines are assumed to proceed A and A′, and the other given points B and B′, A and B being on the same line. Denote the point of intersection by P, and a point on each line having one common co-ordinate, that is, at equal distances from P, where their distance apart is to be obtained by C and C′, C being on A B. Pay strict heed to the signs in everyoperation.

Rates of Approach.—Subtract the respective co-ordinates of A and A′ from those of B and B′; divide the difference of those co-ordinates, at right-angles to that axis of co-ordinates with reference to which the rates are to be reckoned, by the difference of those parallel to it; the quotients will give the rates, plus or minus, as the case may be.

Distance Apart.—Assume a value for the co-ordinate, common to C and C′ as above described, parallel to the axis of approach just used.

Subtract this value, noting its sign, from the corresponding co-ordinates of A and A′, and multiply each difference by the rate of approach of the line to which it belongs. Sum these products each with that co-ordinate of A or A′, according to the line to which the one used may belong, that is at right-angles to the axis of approach. These sums will be the corresponding co-ordinates of C and C′; the subtraction of the one for C from that for C′ will give the desired distance C C′, and the sign of the result will indicate the direction from C on A B to C′ on A′ B′.

Distance from C C′ to P.—Subtract the rate for A′ B′ from the rate for A B; divide C C′ by this difference; and add the quotient to the common co-ordinate of C and C′. The result will be the like co-ordinate of P.

The Other Co-ordinate of P.—Multiply the last found quotient separately by the rate of approach for each line; add these products to the unequal co-ordinates of C and C′, each following its proper line; the results should agree, giving the remaining co-ordinate of P.

The reductions of traverse surveying may be applied to the notes of old surveys, to ascertain whether the old survey or the record of it, which may be all we have, is correct within itself. We need only to find the traverses of the sides, and our inquiry is answered. The reference line is the *meridian*, the sines and cosines of the angles made by the bearings will have the following signs, and if, for any reason, the traverse angles are wanted they will be as follows:

SINE.	BEARING.	COSINE.	TRAVERSE ANGLE.
+	N. E.	+	Bearing.
+	S. E.	−	180°− Bearing.
−	S. W.	−	180° + Bearing.
−	N. W.	+	360°− Bearing.

Where original bearings are used the angles will always close, and an error in them cannot be detected by itself.

Supplying Omissions.—In examining old surveys we often find a line wanting or some notes omitted; occasionally only a portion of the points can be found on the ground. Then the problem arises of finding the missing parts or ascertaining what the old notes indicate as the length and direction of the line joining the points found—a problem known as *supplying omissions*. The statement in books, that any two omissions can be supplied from the remaining notes of a closed survey, has two exceptions—first, when the omitted lengths are those of two parallel sides; and second, when the omitted directions are those of two equal, parallel sides. The three possible cases will be given here to add completeness to this paper.

First:—*Both Omissions in the Same Side.*—Find the sums of the traverses of the given sides. These sums are the traverses of the required side. Find its traverse angle by Tan A=$s \div c$, noting the signs of s and c to determine in what quadrant the angle ends. Find the length by

$$d=\sqrt{(s^2+c^2)}=\frac{s}{\sin A}=\frac{c}{\cos A}$$

Second:—*Omissions in Adjacent Sides.*—Find from the notes of the other sides, by the preceding case, the length and traverse angle of a line joining the ends of these adjacent sides. Find the unknown quantities in the triangle formed by this closing line and the sides in which the omissions occur, and apply them to obtain these omitted quantities.

Third:—*Omissions in Sides not Adjacent.*—Here a sketch, more or less correctly drawn, will usually be found serviceable in seeing the transformations that are required. Find, by the first case, closing lines for those parts of the figure which are separated by the sides in which the omissions occur, that is, closing lines joining their ends. Regard these closing sides, as they lie, as two sides of a triangle, and then solve it for the third side. (This transformation consists simply in conceiving these two closing lines to be shifted parallel to themselves until they meet at one end). Regard the third side above and the sides having omissions as forming a triangle, which they can always be made to do, by shifting as before, without changing their relative position. Solve this last triangle for the quantities lacking to supply the omissions.

When the triangle last named in this third case cannot be formed, but closes up or becomes a line, one of the exceptions noted above as not soluble will be present.

Conclusion.—I would draw attention anew to the following points: We record our data in the field exactly as we read them from the plate or chain, with no reductions and no resulting errors. Every traverse angle, as it is read, is checked by two original vernier readings which determine its direct value, and by four vernier readings of the previous one from which it is reckoned, if the field work is done as advised. The value of the angle should thus be made certain. The angles are checked independently as many times as the survey contains closed figures, and the errors may thus be thrown to the chaining entirely. The computing is then done directly from the field-notes, without transformation and consequent liability to error, and the work is fully checked at every step. A plat may then be made by simple means and few instruments, that is more nearly correct than the survey itself. The area of any part of the piece can be found with great accuracy. Any required information regarding the survey can be easily deduced from the co-ordinates of the piece. Further, the survey is necessarily exhaustive, and we have on record, in the most convenient shape and by a simple system, all the points which may be wanted for future reference and use. These very important considerations should recommend the method of traverse surveying for general use.

ENGINEERING OF TOWN AND COUNTY DRAINS.

By S. N. BEDEN, Pine Run, Michigan.

An old English book says: "Michigan is a low, swampy peninsula in North America," and surveyors once sent out to survey Michigan, after penetrating a short distance into the swamp back of Detroit, returned and reported that Michigan is a swamp too wet to be surveyed.

But enterprising pioneers found that the swamps and marshes of Michigan were interspersed with fertile table lands and valuable timber ridges, which, with vast mineral deposits and navigable waters, make Michigan, in natural wealth, one of the first states in the Union.

Yet about thirty years ago Dr. Cutcheon, the great physiologist, when looking for a home in the West, objected to Michigan on account of the malaria rising from the swamps and marshes.

Still, notwithstanding the many swamps, Michigan has been rapidly settled, for large tracts of swamp lands were offered at reduced prices, and poor people, who had not the means to purchase higher priced lands, went into the swamps and struggled with mud and fevers, to make homes for themselves. It was finally found necessary to have some legislative enactment to facilitate drainage of swamps, and a general drain law was passed, which, though very imperfect, gave us a training school in which the needs of the people were learned. Two years ago the legislature passed a very good drain law, but I find that many commissioners fail to understand the law sufficiently well to operate successfully under it.

Section 6 of the drain law says the drain commissioner shall "cause a survey and measurement of the line of the proposed drain to be made by a competent surveyor, and he shall establish the commencement and terminus, and shall determine the route, width, length and depth thereof."

This statement is a very imperfect one of what the surveyor should do. He should do all this and more. He should set record stakes sufficiently near each other to enable a workman to properly construct the ditch. He should make a map of the ditch, with all lands to be assessed for its construction, and put upon it a table of bearings and distances, and, instead of a profile, I prefer a grade table on the face of the map, showing the numbers and distances of the record stakes, the surface fall from the upper end of the ditch at each stake, the grade of bottom, and cut at each stake.

How to best do these things is what the engineer wishes to know. As the result of several years of practice I have adopted the following plan:

I first determine the position of the upper end of the ditch (for I prefer to commence there), by bearing and distance from some landmark, and at the starting point drive a stake marked 0; then, with the drain commissioner ahead with flag set at the position of the first angle, I find and note the bearing; next I go to the flag and drive a stake marked angle No. 1, while two tape-bearers, with a steel tape ten rods long, graduated from the back end to chains and links, accompanied by two men to bear it and two or three axemen to cut away brush, prepare and drive stakes, measure the distance without marking pins, setting a numbered stake every ten rods.

When the first tape-bearer comes to the angle stake he draws the tape past it, bending the tape around the stake until the rear man is at the last record stake; then I read the tape at the angle stake and write the number of the last record stake + the chains and links read from the tape, at the right and on a line below that on which the bearing was written, as in this table.

NO.	BEARINGS.	DISTANCE BY GRADE STAKES.	WHOLE DISTANCE IN CHAINS.	DISTANCE OF COURSE.
0	N. 25° W.	.....	.....	9.00
1	N. 30° W.	3 + 1.50	9.00	9.25
2	N. 60° W.	7 + 0.75	18.25	8.00
3	N. 10° W.	10 + 1.25	26.25	5.00
"	.....	12 + 1.25	31.25	.....

After going over the ground in this manner, I return to the upper end of the line, and take the difference of levels from bench pegs set opposite to and at such uniform distance from the record stakes that the pegs may not be disturbed by the ditcher. Where it can be done, I make permanent bench marks so that, if some of the bench pegs are moved or lost, the true grade can be readily established. When this is done I am ready for the really important work which is first, to make the estimates for as deep a ditch as the drain commissioner will allow; most open drains are too shallow. Next the engineer should estimate the amount that the soft ground will settle, if the ditch is to run through soft marshes and hard ridges.

I have known a swamp to settle so much from drainage that, in a dry time, the bottom of the ditch in the swamp was a foot and a half lower than the bottom of the outlet of the swamp.

The compactness of the soil through which the ditch is to be dug must be considered in computing the grade. I have resurveyed several ditches where the settling of the ground had so changed the grade, that the ditch was ineffectual.

It is often the case that persons interested in constructing a town or county ditch are not willing to meet the expense of a perfect drain, but are anxious to get rid of surface water. In that event the engineer must estimate the grade and cut, so as to get the greatest flow of water for the limited amount of labor that can be bestowed upon the ditch; but, in no case (if it can be avoided), let the grade of any section be less than the grade of any section above it. For, if the grade diminishes on any section, the *remous* will cause the water to overflow the banks when otherwise the ditch would not be full; and the debris that is carried along by a rapid current will settle when it comes where the water moves more slowly, and will obstruct a drain that otherwise would keep open.

It is very important that the engineer should lay out a perfect grade and that the bottom and sides of the ditch should be made as smooth and even as possible; for slight inequalities in the bottom of a ditch are often of great detriment and they generally become greater by the flowing water.

The Crapo, or State Ditch in Genesee County, has furnished an example of great damage from slight inequalities of bottom. That ditch is designed to drain a large tract of land, and hundreds of acres of crops have often been destroyed or greatly damaged by water on account of the inefficiency of the ditch; though it has several times been cleaned out, yet it was not improved until 1881, when I was employed to lay out a new grade for the ditch. I took levels in it and found but 12.38 feet fall in eight and one-half miles—less than one foot in 3,625 feet. I then drove swamp-oak stakes in the center line of the ditch, with the tops of the stakes at the new grade line. The stakes were set from seven inches above the bottom of the ditch, to twenty-two inches below. The ditch was carefully dug and filled to grade, by which the capacity was nearly doubled, and since then it has never been more than three-fourths full of water.

When there is much fall, a moderate unevenness of the bottom does but little harm; but where the fall is slight a small depression below grade may do much harm; even more than a small elevation; for an elevation may be worn away by the water and the dirt distributed along the ditch, but a small depression will cause an increased velocity of water, which will lift earth from the sink, making it still larger, and deposit this earth below, making a bar in the ditch.

DISCUSSION.

Mr. J. J. WATKINS.—I use the letter A to denote each angle.

Mr. M. W. BULLOCK:—Exhibited the notes and papers used in the case of a very extensive ditch to drain a lake of 12,000 acres. What

are the meanings of the terms *commencement* and *termination* of a ditch as used in the law?

MR. J. M. SANBORN.—The law means the upper end by the word *commencement.*

MR. H. M. CAUKIN.—The law is indefinite; but, judging from a general reading, the law simply means a line with two ends. Where we commence to work is the *commencement* of the ditch.

This opinion seemed to be that of the majority of the Association.

Question :— How shall we determine the amount of land benefited by a drain?

MR. F. HODGMAN.—In one case a Drain Commissioner returned as benefited all the land, dry and wet, of the land-owners near the line of the ditch, instead of the wet land only. The owners were paid for constructing the ditch in ditch orders which they sold in place of using them for paying taxes. They then combined to resist payment of taxes, on the ground that the Commissioner had only the right to assess the wet land.

MR. S. N. BEDEN.—A similar case was carried to the Supreme Court and decided in favor of the Commissioner. I ascertain from the Commissioner the amount of land benefited; for the law provides that we must take his opinion and spread it on the map.

MR. A. SMITH.—All swamp or wet lands are benefited which cannot be drained without the particular ditch for which the assessment is made.

MR. G. A. MARK.—The determination of the exact amount of land benefited is a very difficult problem, and one must take every circumstance into consideration.

REPORT OF COMMITTEE ON INSTRUMENTS.

This committee consisted of Mr. M. W. Bullock, of Howell; Mr. S. N. Beden, of Pine Run, and Mr. J. B. Davis, of Ann Arbor, who was made Secretary.

Owing to an unavoidable delay the committee were not able to go to work till the 11th, and the time was very short for examination of the various articles on exhibition. It is hoped that this will be a sufficient reason to all concerned for the necessarily brief reports upon the several exhibits.

The committee think the interest manifested by all, both dealers and users, was very satisfactory indeed, and they are gratified, as they have no doubt the Association is, at the evidence of interest on the part of dealers, in freely incurring so much expense as was attached to making their exhibits.

EXHIBITS.

W. and L. E. Gurley.—The first exhibit examined was that of W. and L. E. Gurley, of Troy, New York, and it showed plainly the active business energy, skill, and prudence so characteristic of this firm. The exhibit, including all that was of the Messrs. Gurley's make, was by far the largest, most varied and comprehensive of all the collections. There were, in several cases, more than one instrument of a kind.

The Surveyor's Transit with a Solar Attachment was turned over to Mr. Beden, mainly owing to his long and successful experience in its use. He reports very rapid and astonishingly correct work with this transit. The plate is 6½ inches in diameter and reads to one minute of arc. The solar attachment is placed on top of the telescope upon a spindle axis fast at the intersection of the telescope tube and the transit axis. The declination arc reads to 30″; and the vertical circle also to 30″, it being 6 inches in diameter. The lens arm is 5 inches. The bearing of a line, repeatedly taken by Mr. Beden, did not vary to exceed 25 seconds of arc in 12 trials, when he used an instrument of this pattern, and he reports that, with several trials, the bearing of a line can readily be determined to within one-quarter of a minute or 15 seconds of arc.

The Plain Surveyor's Transit had a vernier attached directly to the needle so as to swing round with it for getting close readings. Mr. Amos Smith, of Vandalia, reported very favorably regarding the use of this device. The other features of this transit were those usual in this pattern. There were also several other transits of the "Surveyor's" pattern.

Needle Compasses were present in force. The committee could

not examine half of them. This firm makes as good a compass of any pattern as there is to be had.

The Vernier Pocket Compass with Telescope possesses the various excellent features of this instrument as made by this firm. There is a level on the telescope. The committee cheerfully ask favorable consideration for this useful little compass. One member of the committee learned *why* it is a good thing to have a telescope on a compass. It is easier to look through than are the sights, and, when age dims the eyesight, it is necessary as a magnifier.

The Mountain Transit is of a most excellent pattern, the general design being admirable. It seems to represent the sum of improvement in these desirable little transits. Plate 6 inches, needle 4 inches, vertical arc 6 inches; plate reads to one minute and vertical arc to 30 seconds. There is an extension tripod and adjustable plummet. The plummet is very neat. For those desiring such a plummet this one ought to please, but the committee do not regard such a plummet as at all essential. The extension tripod seemed too limber, but judging from reports of use by members of the Association, the committee were mistaken. There is a gradienter screw to the transit axis. Mr. Francis Hodgman reports favorably regarding its use, but the secretary of the committee has not been successful in obtaining good results with a gradienter. This particular gradienter has one improvement,—the graduated head is so made, that it can be set back to zero for any position of the screw when the telescope level has been set, thus enabling the screw to work with said level. There is such a level on this transit, stadia wires, and a shifting tripod cap. It is a most complete instrument and the committee regard it as a remarkable production. The various devices are very perfect and satisfactory, each in its way. We are surprised to learn that 340 of these transits have been made in six years and that 105 were sold in 1882. The instrument deserves this admirable record.

The Farmer's Level and Rod (price $25 for level and $6 for rod), should be seen to be appreciated. It is an entirely new invention and an excellent level. The level tube is of the same length as the telescope tube, giving great sensitiveness for an instrument of this grade. It may be easily detached from its mountings and used as a carpenter's level; it will be found far more precise for this purpose than any usually sold for mechanics' use; the adjustments are very simple; it is unusually strong and so compact as readily to go into a large pocket, being only $9 \times 2 \times 1\frac{1}{2}$ inches. There are a ball and socket leveling device for quickly leveling up, and screws for the final setting. The rod is a light rod reading to 10.3 feet. A hook is supplied which may be readily screwed into the bottom end, when it is complete for leveling a line of shafting. This outfit is remarkable for the varied uses to which it may be put. It will be found useful to farmers for ditching, leveling foundations, timbers, etc.; to mechanics in various trades employed on constructions of some size; and especially to architects

and contractors in laying out and erecting buildings, by using a trivet with it during erection. The committee regard this level and rod as very creditable additions to the list of instruments.

Among the Wye Levels is one of a very admirable pattern—telescope 18 inches, wyes 10½ inches, level tube 7½ inches, steel center, bronze bearing, detachable from the tripod head in such a manner as to prevent derangement of the wye adjustment by dust. This feature the committee especially commend. The leveling screws are well protected from dirt above and below, and the little cup bearings for the bottoms of the leveling screws are secured to the ends of the screws so as to prevent their loss. This vexatious experience therefore need not occur longer. The general design of this instrument is praiseworthy, and we regard it as a very perfect level. There were a number of other levels exhibited but we must pass them without special mention.

There were several brazed link chains. They show the usual unequalled excellence of this kind of chain as made by this firm. The Grumman chain shown in this collection called forth the fact that it so often fails by breakage, as to practically destroy its value for anything like general use.

Several patterns of Level Rods were shown. The old favorites were present. A manifest defect appeared in the Philadelphia Rod, that one cannot read the vernier when using the long rod, without taking the rod down, which is not as easy as usual, owing to the size of the rod. From the fact that a vernier might be set 16 inches lower, this condition of things is entirely inexcusable.

Buff & Berger.—The next exhibit examined was that of Buff and Berger, of 9 Province Court, Boston, Massachusetts. This firm submitted a transit, two levels, a mining transit and a current meter. Every instrument showed the fine workmanship, care and skill so freely bestowed by this firm upon every thing which comes from their hands. We regard the general designs as very excellent.

The transit was brought from the University of Michigan, at the request of the firm, where it has been in use several years. It has plate 6 inches, reading by vernier to 30 seconds, vertical arc reading to minutes, level on telescope, shifting tripod head, gradienter, and needle. This instrument has given the highest satisfaction during its years of service. The graduations are so perfect that 10 seconds can be estimated on the plate with considerable certainty. It is a superior instrument for general use and shows very great technical skill on the part of this firm.

There were two Levels, an 18 inch wye and an 18 inch dumpy. The wye level is one of the finest levels made for hydraulic engineering. It is very perfect, contains all the desirable devices except the adjustable wye for pointing the level in the most refined work, and is certainly an instrument of precision. It has an adjustable stop for readily setting the crosswires truly horizontal and vertical. A stop is used

by many other makers, but none of them are adjustable, and so are of comparatively little value; since whenever the cross-wire ring is removed it must be put back with great accuracy in order to accommodate the wires again to the fixed stop. The stop should guide the placing of the cross-wires but not control it. This remark is not made because of the monetary value of the stop, for it is added free of cost, but because it is an index of the thoughtful skill of the makers. One cannot go amiss in buying a level of this pattern of this firm if such is needed.

The dumpy was from the State University and has been in use there for some years. It is so handy and accurate, that it is a great favorite. In this one the cross-wires are made adjustable instead of the level tube which is made very secure to the bar. This adjustment is a little easier to make and much more permanent than that of the level tube. If the adjustment of the dumpy could only be as easily made as that of the wye level the former would become very popular.

A complete mining transit was exhibited, having plate 4 inches, reading to one minute, needle 2½ inches, telescope 7 inches, shifting tripod cap, weight of instrument 4 pounds, of tripod that goes with it 3 pounds. We have no doubt that many a man has derived great satisfaction from the use of these superb little instruments.

The current meter shown was intended for use on a pole, or better on an iron tube. It may be shifted along the pole to obtain the velocity of the moving water at different depths. The meter is connected with an electrical register, thus permitting the working of the wheel in the meter (which is turned by the water and indicates the velocity) to be observed in a boat or on shore. This device also permits continuous observations to be carried on at a given place for any length of time. Several meters on the pole will of course give simultaneous velocities at different depths. The delicacy of construction of these instruments cannot be appreciated without that practical experience with them which none of the committee have had. We can therefore only say that everything possible seems to have been done to produce a delicate, yet strong and well protected instrument. The more this meter was studied, the more we appreciated the mechanical difficulties to be overcome and admired the skill displayed in its construction. Should any of our brother members have occasion to use such a meter, we can assure them that this matter has been thoroughly studied by both the maker and the user; such eminent engineers as James B. Francis, Gen. Theo. G. Ellis, Clemens Herschel and D. Farrand Henry have given this subject the most careful attention.

We take occasion to especially mention the tripod in use by this firm. It seems to us to surpass any other tripod with which we are acquainted in the combination of desirable features which it contains. It is very light, stiff, strong, with a broad base for the instrument, and the wood of the legs grasps the brass of the cap, yet it is not clumsy.

Kasson Freeman.—Mr. Freeman, of Grand Rapids, exhibits a very

ingenious telemeter, or instrument for measuring distances. We cannot describe it in detail without numerous illustrations; the description must therefore be general. The instrument consists of a circular brass plate on which are mounted four compass sights, defining two lines at right angles with each other through the center of the plate. The plate consists of three concentric rings which are made into a very ingenious counter for adding, without error, the successive distances between two designated points that it may be necessary to measure with the instrument in order to cover the whole line, said successive measurements being required on account of obstructions. The center of the instrument contains a vertical hole, large enough to permit a sight rod to be run through it. The plates are fixed to a tripod, between the legs of which the sight rod is passed. The whole instrument is placed on its sight rod at the place to which a distance is to be measured from the transit or compass. By means of the sight rod, held vertically, the telemeter is set in line. The tripod legs are spread out and fixed on the ground, with the sight rod carefully kept in the place where it was set in line, and vertical in order to level the plate. The sight rod is then withdrawn from the center of the telemeter. One pair of sights on the telemeter is directed back to the transit or compass. The sight rod is then laid horizontally upon a pair of hooks on the side of the other pair of sights and moved horizontally till a target on its end comes into line with a side wire in the telescope of the transit, or a side slit in the forward compass sight. The distance of this target line from the center of the plate of the telemeter is then measured with a steel tape or by the markings on the sight rod itself. The visual angle at the transit or compass being fixed in the manner indicated, the distance of the target line from the center of the telemeter plate becomes a measure of its distance from the transit or compass. The reduction to the true distance in chains or feet may be made by properly marking the rod or tape, so as to read off this distance at once.

The inventor has provided for repeating the measurement, by reversing the sight pole and quickly setting the target on the other side of the telemeter, by means of another wire on the other side of the central wire in the telescope of the transit, or a second side-slit on the forward compass sight. The half sum of the two distances given by the two trials will be the theoretically true distance, and will eliminate any error arising from placing the telemeter a little to one side of the line in first setting it. Of course the tape or rod may be divided to read half distances, so that it will be only necessary to sum the two readings in order to get the whole distance, without dividing by two. When the range of the visual angle will extend beyond the length of the rod, it is designed that the rod itself may be set in range at the side of the telemeter in the ordinary manner, and its distance from the center of the telemeter measured by the tape line. The sight rod is to be set out at right angles to the line of survey by ranging it in line with

the second pair of sights on the telemeter. Observations should be taken on both sides of the telemeter and the distances measured as in using the target.

These are the essential features of this invention, though many details, necessarily omitted, add greatly to the perfection of its workings. We have then a sort of horizontal stadia. It is of course claimed that, by using this apparatus, many advantages are to be expected. One is, that the necessary reductions in the use of the vertical stadia are entirely avoided, which does not seem to be quite true, as the measurements made with fixed vertical wires in a transit telescope are from the same point within the eyepiece that they would be if the wires were horizontal. Hence there *should* be the same correction, for focus and distance from the center of the transit, in the one case as in the other. In using a compass with a triple slitted forward sight, the most casual examination will show that the point from which the distance is measured is at least as far back as the rear sight. Hence half the distance between the compass sights should be omitted from each measurement. This is plain, so far as corrections are theoretically concerned. There seems to be a real advantage, at first thought, in reducing heights by means of this telemeter and a vertical angle to it, but this gain also disappears upon investigation. For we have two measures to make, independent of the telemeter measure—the heights of both instruments from the ground. One of these is always eliminated in stadia work. We are not able to speak regarding the accuracy of this telemeter as we could make no trials. A further objection to its use is that in places where thick brush and woods are found, a very wide line would be needed. We therefore can see no advantage in the use of this instrument over that of many already well-known and well-tried devices that are much simpler, lighter, cheaper and easier of manipulation. The committee feel constrained to make this criticism, while regarding the invention as giving evidence of great ingenuity on the part of the inventor. We will further add that telemeters of any kind whatever, known to us, cannot in our opinion come into general use for common practice, because they can only be used for obtaining a designated distance, and not for setting a *given* distance on the ground. At least, in every case known to us, where it has been tried, it has been at the sacrifice of the eyesight. Such devices are very useful on explorations and general surveys for topographical and similar purposes, but we do not recommend them elsewhere.

I. H. Leavenworth.—Mr. Leavenworth, of Saginaw City, showed the committee a speaking level rod that is simple and good, like the answers Mr. L. has in past years given us on knotty questions relating to the U. S. Land Survey. We were not able to copy this rod for engraving, but if any wish to know how it is made, we think they can find out by applying to the exhibitor.

Fauth & Co.—Prof. R. C. Carpenter, at the request of Fauth & Co.,

of Washington, D. C., brought from the State Agricultural College an altitude and azimuth instrument of their make. We regret not having had time to become better acquainted with this truly fine instrument. The plate reads to 10 seconds, and the instrument is provided with all those little devices so useful in working with an instrument of this grade. It was an example of the exceedingly fine work which we have understood is always turned out by this firm. We count Fauth & Co. as one of our best firms.

Knox & Shain.—Their Philadelphia Level Rod contained the defect noted above.

Young & Sons.—The exhibit of Young & Sons, Philadelphia, which arrived late, consisted of two transits and a level with accessories. They were brought by Mr. T. N. Watson, the agent for this firm. These instruments contained many new devices. The Wye Level contained a patent telescope, in which the crosswires are placed between the lenses of the eyepiece. The erecting lenses of the eyepiece are movable by a rack and pinion, and thus the telescope is focussed on an object without moving the object glass. Hence there is no object glass slide, and no fitting of this troublesome member is needed. This advantage is partially, if not more than fully, offset by the introduction of a lens between the object glass and the crosswires. The line of sight can no longer be defined with the usual precision unless the lens introduced is most accurately adjusted with reference to the object glass. We had no opportunity to examine into this construction in detail, and therefore could not study it exhaustively. We are not able to speak very fully about its value, but make the above suggestion, and shall want to know much more about it before coming to our final opinion. We hope it is what its external appearance promises; but this matter, in our judgment, is not to be proved by looks and promises. This level has patented horizontal, leveling screws, which work in a horizontal position in a frame against the spindle, moving about a ball and socket joint in the bottom of the frame. The principle and most of the parts of this device are by no means new, and are thought by us to promise well if thoroughly studied out. We think that by using such a principle, instruments can be set somewhat lower, be easily leveled, particularly with cold fingers, and may have centers as long as any one can desire. There are four leveling screws. The tripod was of the old form with round legs running inside of the parts of the tripod cap, but had brass cheek pieces, one on each side of each leg, that were each *singly* secured to the adjoining jaw of the tripod cap by a suitable bolt. This is a genuine improvement and does away with the old objection to this form of tripod, perhaps entirely. There was a fixed stop for setting crosswires in position. The bar seemed too light and the level placed much too high; it might with advantage have been lower. A double, slow motion screw to the spindle clamp was similar to that customarily seen on transits. There was a special device for attaching the level to its

tripod that seemed liable to give trouble, as it did in our presence. We are of the opinion that there is not yet any attachment for this purpose better than a screw, with as broad a bearing for the base of the leveling screws as can be had.

The two transits were of a plain serviceable pattern, which had, as new devices, opposing screws to the slow motion to the transit axis, similar to those commonly seen on the spindle; and a spring arranged so that either screw might be used singly. The object is to give easy access to this motion from either side of the instrument. The same device was applied to the spindle. The plate, slow motion screw presented a new feature. The screw was enclosed in a sleeve, completely covering it, to keep it clean and reduce the wear. Either many makers are not satisfied that there is yet a final form given to slow motion screws, or the pressure of active competition demands a certain variety in the forms of parts produced by different makers, and ingenuity is applied to alter old devices or attach new ones for the purpose of advantage in trade. This possible condition of things calls for the closest scrutiny on the part of buyers to make sure that modifications are good. Both transits had shifting tripod caps. One had a vertical arc attached to the transit axis with a clamping vernier, that is one which is carried on an arm that turns about, and may be clamped to, the transit axis in any of its positions. This device seems to us very convenient, though long in use. The same transit had a level on the telescope. All these instruments were bronze finished. It seemed to us that the form of the wyes might be improved in appearance. The bearing on top of the tripod was unnecessarily small, and too small for the height of the instrument, which was greater than is desirable. On the other hand attention had been given to the plate verniers. They were very open, plain and unusually easy to read, with plenty of light admitted by large cover glasses. This feature we regard with much favor.

It is plain that this firm, with whom rest so many of the interesting historical facts connected with the production of surveying instruments in the United States, retains its vigor in its age and is still actively engaged in striving to further improve this already comparatively perfect product of American manufacture.

We regret not seeing instruments from Mr. L. Beckmann, of Toledo, Ohio. His nearness led us to believe that he would be represented. His catalogues were on the table for distribution. We are sure our members will find it very convenient to deal with Mr. Beckmann, and that his accessibility will make it comparatively easy to obtain any repairs that may be needed on short notice.

Steel tapes—Were shown in considerable variety by different persons, principally by Mr. S. C. Hodgman, of Traverse City, Mich., and the Messrs. Gurley, of Troy, N. Y. We regard the steel tape as the most important new tool we have. Experience has taught us two or three things about them of the first consequence—First, that

they may be made so as not to break easily, a very serious trouble in the case of the older tapes. Second, that they can be made at slight cost, another great advance. Third, that they can be made of any length, up to 80 rods, or so, in one piece, a very important matter in laying out masonry for bridges and in similar work. Fourth, that for ordinary surveying practice, either in city or country, or on any kind of continuous work, the 100 feet, or 66 feet tape needs at most but one mark on it, and that one in the middle, thus further reducing the cost of an outfit to a remarkable minimum. Mr. Hodgman and others had already reduced the cost surprisingly, much below the price of even a cheap and comparatively worthless chain; but we know that the marks on steel tapes greatly increase their price. These marks may be reduced to zero, or at most one, as above noted, in this way—measure out the proper number of full chains and use a short and fine steel tape for the fractional measurement at the end of a distance. The last pin or mark may be short of, or beyond, the point to which the measurement runs. Measure this fraction with a pocket steel tape and add it to, or subtract it from, as the case may be, the number of full chains. If a 100-feet tape has a mark in the middle of it, half a chain, or 50 feet can be used at the end, and a 25-feet pocket steel tape will complete every possible measurement. In the case of a 66 feet tape with one mark at 33 feet, or 50 links, a 16½ feet, or 25 link pocket tape will complete all measurements. In case of the 20 metre tape, a 5 metre tape for the pocket is all that is needed. A reference to the catalogues will easily determine what this outfit will cost, and the pocket tape will be found a wonderfully handy companion in a great variety of circumstances. Your committee, therefore, urge the importance of this matter on all surveyors, believing it will bring such comfort, speed and accuracy into work as the older measures never can give. We are constrained to say that the greatest lack now is a suitable reel for the long tape for chaining purposes. One of our members, Mr. J. B. Davis, has given this point some attention and will be glad to consult freely with others about it, in the hope of removing the last difficulty in the use of this kind of a measure.

Your committee respectfully report that it is deemed advisable by us for every angular instrument to be provided with a shifting tripod cap of good pattern. We also recommend the so-called "Cloth finish" to all instruments, or the bronze instead of the bright finish.

Mr. F. M. Priest, of Bryan, O., exhibited a good form of speaking level rod, reading to hundredths, somewhat like a Philadelphia rod. We are not able to illustrate this rod, and those desiring it will need to apply to Mr. Priest, whose name and address will be found in our roll of members.

This gentleman also handed us a sheet of numbers, the same being a sample of his earthwork tables. We did not learn the whole history of these tables, and cannot therefore pass upon them. Their use seemed simple, as it is only necessary to enter the table with the

two end depths in order to take out the contents of a 100-foot prismoid. Here again we felt exceedingly the want of a proper amount of time, and apologize to Mr. Priest and the Association for this short and unworthy notice.

In closing our report, it gives us great pleasure to recall the fact that we have found so much which commands our hearty approval, and so little which we find it necessary to question or condemn. We think those who supply our profession with instruments are keeping their work fully up with other branches of American manufacture in comparison with the productions of other countries. We have been highly interested in this brief examination of these important matters, and most seriously regret our inability to give them the consideration they so richly deserve.

Very Respectfully Submitted,

[Signed] M. W. BULLOCK, Chairman,
S. N. BEDEN,
J. B. DAVIS, Secretary.

A LEVEL LINE OF SIGHT.

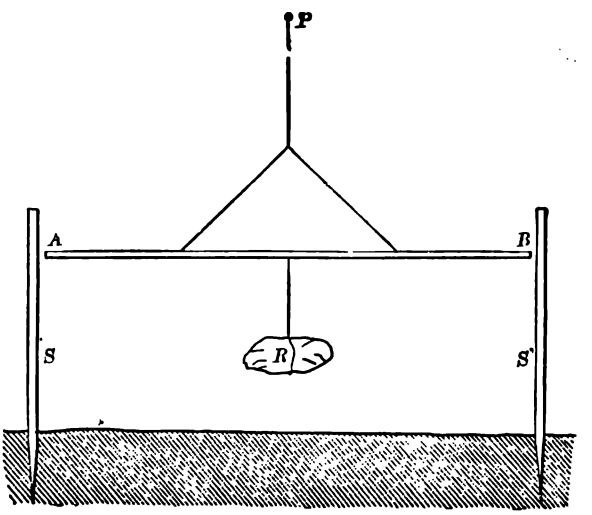
BY J. B. DAVIS, ASST. PROF. CIVIL ENGINEERING, U. OF M.

The following method of obtaining a level line of sight, when no instruments are at hand, seems to me so good that I venture to present it here.

Suspend from some fixed point of support, P, by stout cords, as indicated, a pole of any shape A B. From this pole hang a heavy weight R, as shown. Sharpen one end of the pole, as at A, using the longer end. Set two stakes, S and S′, so that the point at A when swung round will just touch them. Blaze off on each stake a smooth place to receive marks. After taking the twist out of the supporting cord carefully swing the rod A B round, noting with a pencil or a knife the exact point where the end A will touch the stakes. Repeat the trials. Choose points on S and S′ that are most satisfactory, and they will determine a level line of sight.

The pole A B being of some size and length, the points on S and S′ may be far enough apart horizontally, to give quite a satisfactory line of sight.

A building may be leveled by this means. A cross-section could be staked out on a railroad. Levels for many common purposes on a limited area can thus be obtained.



VARIATION OF THE NEEDLE.

From the following table it will be noticed that the line of no variation has obtained a position somewhat east of the center of the State, and is moving westward at a rate of 5′ to 7′ per year. The annual change is much greater at present than it was several years ago, as is shown by observations of Mr. F. Hodgman. Where the interval was great, 40 to 50 years, the annual change is small, but in recent years the change is much greater.

In order to answer numerous inquiries, and also because the same can not be found brought down to date in a work available to surveyors, the Secretary has computed the following table of azimuth of Polaris when at elongation for January 1st, 1884. This table was computed by formula,

$$\text{Sine Azimuth} = \frac{\text{Sine polar distance}}{\text{Cos latitude}}.$$

On January 1. 1884, the polar distance of Polaris is 2° 18′ 35″, and is decreasing at rate of 19″ per year.

AZIMUTH OF POLARIS AT ELONGATION, January 1, 1884:

Latitude	40°	41°	42°	43°	44°	45°	46°
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Azimuth	1 42 35	1 44 08	1 45 45	1 47 28	1 49 15	1 51 09	1 53 05

The azimuth of Polaris is decreasing at about the rate of 20″ per year.

VARIATION OR DECLINATION OF THE NEEDLE AS REPORTED BY VARIOUS OBSERVERS.

Date.	Variation.	Annual Change.	Locality.	County.	Authority.	Remarks.
November 1882	3° 23′ W	.....	Ecorse	Wayne	E. T. Goodale	
Jan. 1882	0 56 W	.....	Sault Ste. Marie	Chippewa	Geo. H. Carleton	
1880	0 13 W	3′	Detroit	Wayne	U. S. Lake Survey	
Jan. 25, 1883, 5 P. M.	2 9 40″ W	.....	Ann Arbor	Washtenaw	I. O. Walker	By comparing needle with observatory meridian.
Jan. 29, 1883, 2 P. M.	1 30 W	.....	Morenci	Lenawee	James Blair	Observation with solar compass.
June 15. '82, 3 P. M.	0 15 W	.....	Ypsilanti	Washtenaw	C. F. R. Bellows	
1878	0 45 E	.....	Ypsilanti	Washtenaw	C. S. Woodward	
1851	1 12 E	4.94′	Ypsilanti	Washtenaw	C. S. Woodward	
1882	1 20 E	.....	Lyndon	Washtenaw	J. K. Yocum	
1874	2 14 E	6¾′	Lyndon	Washtenaw	J. K. Yocum	
January 1883	0 15 W	.....	Lapeer	Lapeer	J. J. Watkins	By comparing bearing with known azimuth of a certain line.
January 1883	0 20 E	.....	St. Louis	Gratiot	S. S. Hastings	By comparing bearing with known azimuth of a certain line.
October 1882	0 30 E	.....	Charlevoix	Charlevoix	J. R. Dixon	
January 25, 1883	0 49 E	.....	Winfield	Ingham	Lee S. Cobb	From elongation of Polaris at elongation.
February 15, 1883	0 55 E	.....	Lansing	Ingham	Wm. Appleton	From meridian established by U. S. Lake Survey N. end.
1876	1 40 E	6 3-7′	Lansing	Ingham	H.D.Bartholemew	From meridian established by U. S. Lake Survey N. end.
Fall 1882	1 16 E	.....	Mason	Ingham	T. J. Brown	Azimuth line by U. S. Lake Survey.
April 1882	1 18 E	.....	Mason	Ingham	A. P. Drake	Azimuth line by U. S. Lake Survey.

July 15, 1882	0° 49′	E	.....	Traverse City	Grand Traverse	S. C. Hodgman	
April, 1882	1 20	E	.....	Greenville	Montcalm	H. M. Caukin	Elongation of Polaris.
August, 1881	1 11	E	.....	Gaylord	Otsego	John M. Sanborn.	
October, 1878	1 07	E	.....	Sec. 18, T 14 N, R 3 W	Isabella	A. R. Arnold	
January, 1883	1 15	E	.....	W. Co. Line, Chelsea	Washtenaw	J. K. Yocum	
January 26, 1883	1 18	E	.....	Hillsdale	Hillsdale	Geo. A. Mark	Line established by U. S. Lake Sur.
January 7, 1881	1 27	E	4½′	Hillsdale	Hillsdale	Geo. A. Mark	Line established by U. S. Lake Sur.
1879	1 30	E	.....	Marshall	Calhoun	B. F. Welles	
July, 1882	1 34	E	.....	Big Rapids	Mecosta	H. I. Orwig	
February 9, 1883	2 10	E	.....	Vandalia	Cass	Amos Smith	
January, 1882	2 15	E	5′	Vandalia	Cass	Amos Smith	
January, 1883	2 11	E	.....	Windsor	Eaton	M. H. Bailey	
1881	2 13	E	3½′	Colon	St. Joseph	O. H. Todd	
January, 1882	2 23	E	6⅝′	Lawton	Van Buren	Prof. C. D. Lawton	
January, 1882	2 30	E	6¼′	South Haven	Van Buren	A. J. Pierce	
June, 20, 1882	2 43	E	5′	Kalamazoo	Kalamazoo	F. Hodgman	From meridian established by U. S. Lake Survey.
.....	.....	.....	2.7′	Bronson	Kalamazoo	F. Hodgman	Average difference of bearings from 1832 to 1882.
.....	.....	.....	1.8′	T 1 S, R 9 W	Kalamazoo	F. Hodgman	Average difference of bearings from 1839 to 1882.
.....	.....	.....	2.4′	T 2 S, R 10 W	Kalamazoo	F. Hodgman	Average difference of bearings from 1840 to 1873.
January, 1882	2° 50′	E	.....	Ferrysburg	Ottawa	H. C. Pearsons	
November 20, 1882	2 59	E	.....	Sec. 1, T 8 S, R 20 W	Berrien	T. Love	
1881	3 11	E	.....	Avery	Berrien	T. Love	
January, 1882	3 10	E	.....	Manistee	Manistee	M. S. Cook	
1880	3 25	E	.....	Marquette	Marquette	C. D. Lawton	
1880	4 42	E	.....	Ontonagon	Ontonagon	G. P. Cummings	
February 3, 1883	3 45	E	.....	Sec. 21, T 49 N, R 38 W	.....	C. S. Woodard	Transit on Polaris.
July, 1851	6 5	E	.....	Sec. 21, T 49 N, R 38 W	.....	C. S. Woodard	Solar Compass.
February, 1883	4	E	.....	Sec. 33, T 50 N, R 38 W	.....	C. S. Woodard	
February 13, 1883	3 20	E	.....	Sec. 14, T 48 N, R 38 W	.....	C. S. Woodard	
August, 1851	5 40	E	.....	Sec. 14, T 48 N, R 38 W	.....	C. S. Woodard	Solar Compass.

THE JUDICIAL FUNCTIONS OF SURVEYORS.

BY JUSTICE COOLEY OF THE MICHIGAN SUPREME COURT.
REPRINTED FROM PROCEEDINGS OF 1881.

When a man has had a training in one of the exact sciences, where every problem within its purview is supposed to be susceptible of accurate solution, he is likely to be not a little impatient when he is told that, under some circumstances, he must recognize inaccuracies, and govern his action by facts which lead him away from the results which theoretically he ought to reach. Observation warrants us in saying that this remark may frequently be made of surveyors.

In the State of Michigan, all our lands are supposed to have been surveyed once or more, and permanent monuments fixed to determine the boundaries of those who should become proprietors. The United States, as original owner, caused them all to be surveyed once by sworn officers, and as the plan of subdivision was simple, and was uniform over a large extent of territory, there should have been, with due care, few or no mistakes; and long rows of monuments should have been perfect guides to the place of any one that chanced to be missing. The truth unfortunately is that the lines were very carelessly run, the monuments inaccurately placed; and, as the recorded witnesses to these were many times wanting in permanency, it is often the case that when the monument was not correctly placed, it is impossible to determine by the record with the aid of anything on the ground, where it was located. The incorrect record of course becomes worse than useless when the witnesses it refers to have disappeared.

It is, perhaps, generally supposed that our town plats were more accurately surveyed, as indeed they should have been, for in general there can have been no difficulty in making them sufficiently perfect for all practical purposes. Many of them, however, were laid out in the woods; some of them by proprietors themselves, without either chain or compass, and some by imperfectly trained surveyors, who, when land was cheap, did not appreciate the importance of having correct lines to determine boundaries when land should become dear. The fact probably is that town surveys are quite as inaccurate as those made under authority of the general government.

It is now upwards of fifty years since a major part of the public surveys in what is now the State of Michigan were made under authority of the United States. Of the lands south of Lansing, it is now forty years since the major part were sold, and the work of improvement begun. A generation has passed away since they were converted

into cultivated farms, and few if any of the original corner and quarter stakes now remain.

The corner and quarter stakes were often nothing but green sticks driven into the ground. Stones might be put around or over these if they were handy, but often they were not, and the witness trees must be relied upon after the stake was gone. Too often the first settlers were careless in fixing their lines with accuracy while monuments remained, and an irregular brush fence, or something equally untrustworthy, may have been relied upon to keep in mind where the blazed line once was. A fire running through this might sweep it away, and if nothing was substituted in its place, the adjoining proprietors might in a few years be found disputing over their lines, and perhaps rushing into litigation, as soon as they had occasion to cultivate the land along the boundary.

If now the disputing parties call in a surveyor, it is not likely that any one summoned would doubt or question that his duty was to find, if possible, the place of the original stakes which determined the boundary line between the proprietors. However erroneous may have been the original survey, the monuments that were set must nevertheless govern, even though the effect be to make one half-quarter section ninety acres and the one adjoining but seventy; for parties buy or are supposed to buy in reference to those monuments, and are entitled to what is within their lines, and no more. be it more or less. (*McIver vs. Walker*, 4 Wheaton's Reports, 444; *Land Co. vs. Saunders*, 103 U. S. Reports, 316; *Cottingham vs. Parr*, 93 Ill. Reports, 233; *Bunton vs. Cardwell*, 53 Texas Reports, 408; *Watson vs. Jones* 85 Penn., Reports, 117.

While the witness trees remain, there can generally be no difficulty in determining the locality of the stakes. When the witness trees are gone, so that there is no longer record evidence of the monuments, it is remarkable how many there are who mistake altogether the duty that now devolves upon the surveyor. It is by no means uncommon that we find men, whose theoretical education is supposed to make them experts, who think that when the monuments are gone, the only thing to be done is to place new monuments where the old ones should have been, and where they would have been if placed correctly. This is a serious mistake. The problem is now the same that it was before: To ascertain by the best lights of which the case admits, where the original lines were. The mistake above alluded to is supposed to have found expression in our legislation; though it is possible that the real intent of the act to which we shall refer is not what is commonly supposed.

An act passed in 1869, Compiled Laws, § 593, amending the laws respecting the duties and powers of county surveyors, after providing for the case of corners which can be identified by the original field notes or other unquestionable testimony, directs as follows:

"*Second.* Extinct interior section corners must be re-established at the

intersection of two right lines joining the nearest known points on the original section lines east and west and north and south of it.

"*Third.* Any extinct quarter-section corner, except on fractional lines, must be re-established equidistant and in a right line between the section corners; in all other cases at its proportionate distance between the nearest original corners on the same line."

The corners thus determined the surveyors are required to perpetuate by noting bearing trees when timber is near.

To estimate properly this legislation, we must start with the admitted and unquestionable fact that each purchaser from government bought such land as was within the original boundaries, and unquestionably owned it up to the time when the monuments became extinct. If the monument was set for an interior section corner, but did not happen to be "at the intersection of two right lines joining the nearest known points on the original section lines east and west and north and south of it," it nevertheless determined the extent of his possessions, and he gained or lost according as the mistake did or did not favor him.

It will probably be admitted that no man loses title to his land or any part thereof merely because the evidences become lost or uncertain. It may become more difficult for him to establish it as against an adverse claimant, but theoretically the right remains; and it remains as a potential fact so long as he can present better evidence than any other person. And it may often happen that, notwithstanding the loss of all trace of a section corner or quarter stake, there will still be evidence from which any surveyor will be able to determine with almost absolute certainty where the original boundary was between the government subdivisions.

There are two senses in which the word extinct may be used in this connection: One the sense of physical disappearance: the other the sense of loss of all reliable evidence. If the statute speaks of extinct corners in the former sense, it is plain that a serious mistake was made in supposing that surveyors could be clothed with authority to establish new corners by an arbitrary rule in such cases. As well might the statute declare that if a man loses his deed, he shall lose his land altogether.

But if by extinct corner is meant one in respect to the actual location of which all reliable evidence is lost, then the following remarks are pertinent:

1. There would undoubtedly be a presumption in such a case that the corner was correctly fixed by the government surveyor where the field notes indicated it to be.

2. But this is only a presumption and may be overcome by any satisfactory evidence showing that in fact it was placed elsewhere.

3. No statute can confer upon a county surveyor the power to "establish" corners, and thereby bind the parties concerned. Nor is this a question merely of conflict between State and Federal law; it

is a question of property right. The original surveys must govern, and the laws under which they were made must govern, because the land was bought in reference to them; and any legislation, whether state or federal, that should have the effect to change these, would be inoperative, because disturbing vested rights.

4. In any case of disputed lines, unless the parties concerned settle the controversy by agreement, the determination of it is necessarily a judicial act, and it must proceed upon evidence, and give full opportunity for a hearing. No arbitrary rules of survey or of evidence can be laid down whereby it can be adjudged.

The general duty of a surveyor in such a case is plain enough. He is not to assume that a monument is lost until after he has thoroughly sifted the evidence and found himself unable to trace it. Even then he should hesitate long before doing anything to the disturbance of settled possessions. Occupation, especially if long continued, often affords very satisfactory evidence of the original boundary when no no other is attainable; and the surveyor should inquire when it originated, how, and why the lines were then located as they were, and whether a claim of title has always accompanied the possession, and give all the facts due force as evidence. Unfortunately, it is known that surveyors sometimes, in supposed obedience to the State statute, disregard all evidences of occupation and claim of title, and plunge whole neighborhoods into quarrels and litigation by assuming to "establish" corners at points with which the previous occupation cannot harmonize. It is often the case that where one or more corners are found to be extinct, all parties concerned have acquiesced in lines which were traced by the guidance of some other corner or landmark, which may or may not have been trustworthy; but to bring these lines into discredit when the people concerned do not question them not only breeds trouble in the neighborhood, but it must often subject the surveyor himself to annoyance and perhaps discredit, since in a legal controversy the law as well as common sense must declare that a supposed boundary line long acquiesced in is better evidence of where the real line should be than any survey made after the original monuments have disappeared. *Stewart vs. Carleton*, 31 Mich. Reports, 270; *Diehl vs. Zanger*, 39 Mich. Reports, 601; *Dupont vs. Starring*, 42 Mich. Reports, 492. And county surveyors, no more than any others, can conclude parties by their surveys.

The mischiefs of overlooking the facts of possession must often appear in cities and villages. In towns the block and lot stakes soon disappear; there are no witness trees and no monuments to govern except such as have been put in their places, or where their places were supposed to be. The streets are likely to be soon marked off by fences, and the lots in a block will be measured off from these, without looking farther. Now it may perhaps be known in a particular case that a certain monument still remaining was the starting point in the original survey of the town plat; or a surveyor settling in the

town may take some central point as the point of departure in his surveys, and assuming the original plat to be accurate, he will then undertake to find all streets and all lots by course and distance according to the plat, measuring and estimating from his point of departure. This procedure might unsettle every line and every monument existing by acquiescence in the town; it would be very likely to change the lines of streets, and raise controversies everywhere. Yet this is what is sometimes done; the surveyor himself being the first person to raise the disturbing questions.

Suppose for example, a particular village street has been located by acquiescence and user for many years, and the proprietors in a certain block have laid off their lots in reference to this practical location. Two lot owners quarrel, and one of them calls in a surveyor that he may be sure that his neighbor shall not get an inch of land from him. This surveyor undertakes to make his survey accurate, whether the original was so or not, and the first result is, he notifies the lot owners that there is error in the street line, and that all fences should be moved, say one foot to the east. Perhaps he goes on to drive stakes through the block according to this conclusion. Of course, if he is right in doing this, all lines in the village will be unsettled; but we will limit our attention to the single block. It is not likely that the lot owners generally will allow the new survey to unsettle their possessions, but there is always a probability of finding some one disposed to do so. We shall then have a lawsuit; and with what result?

It is a common error that lines do not become fixed by acquiescence in a less time than twenty years. In fact, by statute, road lines may become conclusively fixed in ten years; and there is no particular time that shall be required to conclude private owners, where it appears that they have accepted a particular line as their boundary, and all concerned have cultivated and claimed up to it. *McNamara vs. Seaton*, 82 Ill. Reports, 498; *Bunce vs. Bidwell*, 43 Mich. Reports, 542. Public policy requires that such lines be not lightly disturbed, or disturbed at all after the lapse of any considerable time. The litigant, therefore, who in such a case pins his faith on the surveyor, is likely to suffer for his reliance, and the surveyor himself to be mortified by a result that seems to impeach his judgment.

Of course nothing in what has been said can require a surveyor to conceal his own judgment, or to report the facts one way when he believes them to be another. He has no right to mislead, and he may rightfully express his opinion that an original monument was at one place, when at the same time he is satisfied that acquiescence has fixed the rights of parties as if it were at another. But he would do mischief if he were to attempt to "establish" monuments which he knew would tend to disturb settled rights; the farthest he has a right to go, as an officer of the law, is to express his opinion where the monument should be, at the same time that he imparts the informa-

tion to those who employ him, and who might otherwise be misled, that the same authority that makes him an officer and entrusts him to make surveys, also allows parties to settle their own boundary lines, and considers acquiescence in a particular line or monument, for any considerable period, as strong, if not conclusive, evidence of such settlement. The peace of the community absolutely requires this rule. *Joyce vs. Williams*, 26 Mich. Reports, 332. It is not long since, that, in one of the leading cities of the State, an attempt was made to move houses two or three rods into a street, on the ground that a survey under which the street had been located for many years, had been found on a more recent survey to be erroneous.

From the foregoing it will appear that the duty of the surveyor where boundaries are in dispute must be varied by the circumstances. 1. He is to search for original monuments, or for the places where they were originally located, and allow these to control if he finds them, unless he has reason to believe that agreements of the parties, express or implied, have rendered them unimportant. By monuments in the case of government surveys we mean of course the corner and quarter stakes: blazed lines or marked trees on the lines are not monuments: they are merely guides or finger posts, if we may use the expression, to inform us with more or less accuracy where the monuments may be found. 2. If the original monuments are no longer discoverable, the question of location becomes one of evidence merely. It is merely idle for any state statute to direct a surveyor to locate or "establish" a corner, as the place of the original monument, according to some inflexible rule. The surveyor on the other hand must inquire into all the facts; giving due prominence to the acts of parties concerned, and always keeping in mind, *first*, that neither his opinion nor his survey can be conclusive upon parties concerned; *second*, that courts and juries may be required to follow after the surveyor over the same ground, and that it is exceedingly desirable that he govern his action by the same lights and rules that will govern theirs. On town plats if a surplus or deficiency appears in a block, when the actual boundaries are compared with the original figures, and there is no evidence to fix the exact location of the stakes which marked the division into lots, the rule of common sense and of law is that the surplus or deficiency is to be apportioned between the lots, on an assumption that the error extended alike to all parts of the block. *O'Brien vs. McGrane*, 29 Wis. Reports, 446; *Quinnin vs Reixers*, 46 Mich. Reports, 605.

It is always possible when corners are extinct that the surveyor may usefully act as a mediator between parties, and assist in prevent-legal controversies by settling doubtful lines. Unless he is made for this purpose an arbitrator by legal submission, the parties, of course even if they consent to follow his judgment, cannot on the basis of mere consent, be compelled to do so; but if he brings about an agreement, and they carry it into effect by actually conforming their occu-

pation to his lines, the action will conclude them. Of course, it is desirable that all such agreements be reduced to writing; but this is not absolutely indispensable if they are carried into effect without.

Meander lines. The subject to which allusion will now be made, is taken up with some reluctance, because it is believed the general rules are familar. Nevertheless it is often found that surveyors misapprehend them, or err in their application, and as other interesting topics are somewhat connected with this, a little time devoted to it will probably not be altogether lost. The subject is that of meander lines. These are lines traced along the shores of lakes, ponds and considerable rivers as the measures of quantity when sections are made fractional by such waters. These have determined the price to be paid when government lands were bought, and perhaps the impression still lingers in some minds that the meander lines are boundary lines, and all in front of them remains unsold. Of course this is erroneous. There was never any doubt that, except on the large navigable rivers, the boundary of the owners of the banks is the middle line of the river; and while some courts have held that this was the rule on all fresh water streams, large and small, others have held to the doctrine that the title to the bed of the stream below low-water mark is in the State, while conceding to the owners of the banks all riparian rights. The practical difference is not very important. In this State the rule that the center line is the boundary line is applied to all our great rivers, including the Detroit, varied somewhat by the circumstance of there being a distinct channel for navigation in some cases with the stream in the main shallow, and also sometimes by the existence of islands.

The troublesome questions for surveyors present themselves when the boundary line between two contiguous states is to be continued from the meander line to the center line of the river. Of course the original survey supposes that each purchaser of land on the stream has a water front of the length shown by the field notes; and it is presumable that he bought this particular land because of that fact. In many cases it now happens that the meander line is left some distance from the shore by the gradual change of course of the stream or diminution of the flow of water. Now the dividing line between two government subdivisions might strike the meander line at right angles, or obliquely; and, in some cases, if it were continued in the same direction to the center line of the river, might cut off from the water one of the subdivisions entirely, or at least cut it off from any privilege of navigation, or other valuable use of the water, while the other might have a water front much greater than the length of a line crossing it at right angles to its side lines. The effect might be that, of two government subdivisions of equal size and cost, one would be of very great value as water-front property, and the other comparatively valueless. A rule which would produce this result would not be just, and it has not been recognized in the law.

Nevertheless it is not easy to determine what ought to be the correct rule for every case. If the river has a straight course, or one nearly so, every man's equities will be preserved by this rule: Extend the line of division between the two parcels from the meander line to the center line of the river, as nearly as possible at right angles to the general course of the river at that point. This will preserve to each man the water front which the field notes indicated, except as changes in the water may have effected it, and the only inconvenience will be that the division line between different subdivisions is likely to be more or less deflected where it strikes the meander line.

This is the legal rule, and it is not limited to government surveys, but applies as well to water lots which appear as such on town plats. *Bay City Gas Light Co. v. The Industrial Works*, 28 Mich. Reports, 182. It often happens, therefore, that the lines of city lots bounded on navigable streams are deflected as they strike the bank, or the line where the bank was when the town was first laid out.

When the stream is very crooked, and especially if there are short bends, so that the foregoing rule is incapable of strict application, it is sometimes very difficult to determine what shall be done; and in many cases the surveyor may be under the necessity of working out a rule for himself. Of course his action cannot be conclusive; but if he adopts one that follows, as nearly as the circumstances will admit, the general rule above indicated, so as to divide as near as may be the bed of the stream among the adjoining owners in proportion to their lines upon the shore, his division, being that of an expert, made upon the ground and with all available lights, is likely to be adopted as law for the case. Judicial decisions, into which the surveyor would find it prudent to look under such circumstances, will throw light upon his duties and may constitute a sufficient guide when peculiar cases arise. Each riparian lot owner ought to have a line on the legal boundary, namely, the center line of the stream, proportioned to the length of his line on the shore; and the problem in each case is, how this is to be given him. Alluvion, when a river imperceptibly changes its course, will be apportioned by the same rules.

The existence of islands in a stream, when the middle line constitutes a boundary, will not affect the apportionment unless the islands were surveyed out as government subdivisions in the original admeasurement. Wherever that was the case, the purchaser of the island divides the bed of the stream on each side with the owner of the bank, and his rights also extend above and below the solid ground, and are limited by the peculiarities of the bed and the channel. If an island was not surveyed as a government subdivision previous to the sale of the bank, it is of course impossible to do this for the purposes of government sale afterwards, for the reason that the rights of the bank owners are fixed by their purchase: when making that, they have a right to understand that all land between the meander lines, not separately surveyed and sold, will pass with the shore in the

government sale; and having this right, anything which their purchase would include under it cannot afterward be taken from them. It is believed, however, that the federal courts would not recognize the applicability of this rule to large navigable rivers, such as those uniting the great lakes.

On all the little lakes of the State which are mere expansions near their mouths of the rivers passing through them—such as the Muskegon, Pere Marquette and Manistee—the same rule of bed ownership has been judicially applied that is applied to the rivers themselves; and the division lines are extended under the water in the same way. *Rice v. Ruddiman*, 10 Mich., 125. If such a lake were circular, the lines would converge to the center; if oblong or irregular, there might be a line in the middle on which they would terminate, whose course would bear some relation to that of the shore. But it can seldom be important to follow the division line very far under the water, since all private rights are subject to the public rights of navigation and other use, and any private use of the lands inconsistent with these would be a nuisance, and punishable as such. It is sometimes important, however, to run the lines out for some considerable distance, in order to determine where one may lawfully moor vessels or rafts, for the winter, or cut ice. The ice crop that forms over a man's land of course belongs to him. *Lorman v. Benson*, 8 Mich., 18; *Peoples' Ice Co. v. Steamer Excelsior*, recently decided.

What is said above will show how unfounded is the notion, which is sometimes advanced, that a riparian proprietor on a meandered river may lawfully raise the water in the stream without liability to the proprietors above, provided he does not raise it so that it overflows the meander line. The real fact is that the meander line has nothing to do with such a case, and an action will lie whenever he sets back the water upon the proprietor above, whether the overflow be below the meander lines or above them.

As regards the lakes and ponds of the State, one may easily raise questions that it would be impossible for him to settle. Let us suggest a few questions, some of which are easily answered, and some not:

1. To whom belongs the land under these bodies of water, where they are not mere expansions of a stream flowing through them?

2. What public rights exist in them?

3. If there are islands in them which were not surveyed out and sold by the United States, can this be done now?

Others will be suggested by the answers given to these.

It seems obvious that the rules of private ownership which are applied to rivers cannot be applied to the great lakes. Perhaps it should be held that the boundary is at low water mark, but improvements beyond this would only become unlawful when they became nuisances. Islands in the great lakes would belong to the United States until sold, and might be surveyed and measured for sale at any time. The right to take fish in the lakes, or to cut ice, is public like

the right of navigation, but is to be exercised in such manner as not to interfere with the rights of shore owners. But so far as these public rights can be the subject of ownership, they belong to the State, not to the United States; and, so it is believed, does the bed of a lake also. *Pollard v. Hagan*, 3 Howard's U. S. Reports. But such rights are not generally considered proper subjects of sale, but, like the right to make use of the public highways, they are held by the State in trust for all the people.

What is said of the large lakes may perhaps be said also of many of the interior lakes of the State; such, for example, as Houghton, Higgins, Cheboygan, Burt's, Mullet, Whitmore, and many others. But there are many little lakes or ponds which are gradually disappearing, and the shore proprietorship advances *pari passu* as the waters recede. If these are of any considerable size—say, even a mile across—there may be questions of conflicting rights which no adjudication hitherto made could settle. Let any surveyor, for example, take the case of a pond of irregular form, occupying a mile square or more of territory, and undertake to determine the rights of the shore proprietors to its bed when it shall totally disappear, and he will find he is in the midst of problems such as probably he has never grappled with, or reflected upon before. But the general rules for the extension of shore lines, which have already been laid down, should govern such cases, or at least should serve as guides in their settlement. *Note.*—Since this address was delivered some of these questions have received the attention of the Supreme Court of Michigan in the cases of *Richardson v. Prentiss*, 48 Mich. Reports, 88, and *Backus v. Detroit*, Albany Law Journal, vol. 26, p. 428.

Where a pond is so small as to be included within the lines of a private purchase from the government, it is not believed the public have any rights in it whatever. Where is it not so included, it is believed they have rights of fishery, rights to take ice and water, and rights of navigation for business or pleasure. This is the common belief, and probably the just one. Shore rights must not be so exercised as to disturb these, and the states may pass all proper laws for their protection. It would be easy with suitable legislation to preserve these little bodies of water as permanent places of resort for the pleasure and recreation of the people, and there ought to be such legislation.

If the State should be recognized as owner of the beds of these small lakes and ponds, it would not be owner for the purpose of selling. It would be owner only as a trustee for the public use; and a sale would be inconsistent with the right of the bank owners to make use of the water in its natural condition in connection with their estates. Some of them might be made salable lands by draining; but the State could not drain, even for this purpose, against the will of the shore owners, unless their rights were appropriated and paid for.

Upon many questions that might arise between the State as owner

of the bed of a little lake and the shore owners, it would be presumptuous to express an opinion now, and fortunately the occasion does not require it.

I have thus indicated a few of the questions with which surveyors may now and then have occasion to deal, and to which they should bring good sense and sound judgment. Surveyors are not and cannot be judicial officers, but in a great many cases they act in a *quasi* judicial capacity with the acquiescence of parties concerned; and it is important for them to know by what rules they are to be guided in the discharge of their judicial functions. What I have said cannot contribute much to their enlightenment, but I trust will not be wholly without value.

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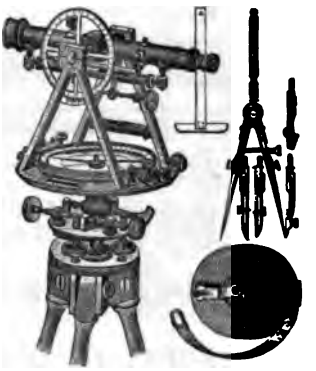

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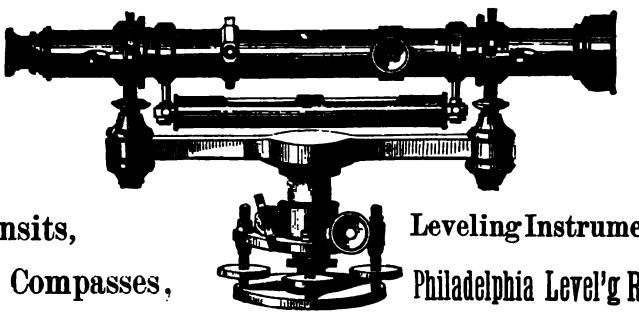

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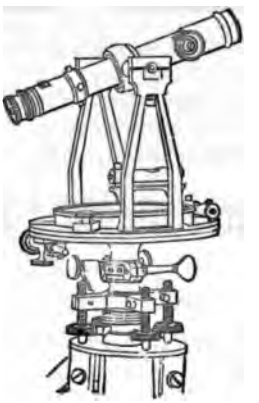

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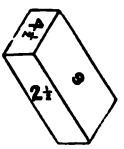

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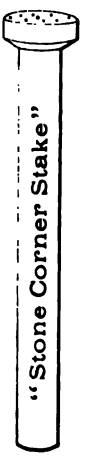

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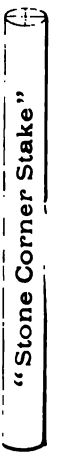

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HELD AT

East Saginaw, Jan. 1, 2, 3, and 4, 1884.

SIXTH MEETING WILL BE HELD AT LANSING, MICHIGAN, FEBRUARY 17, 1885.

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1884.

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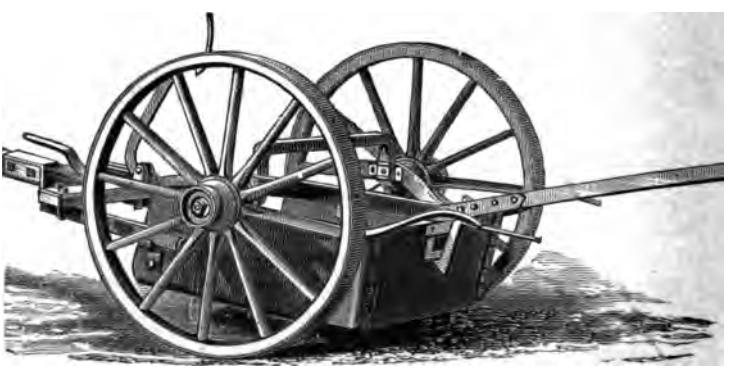

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THE MICHIGAN ASSOCIATION

—OF—

SURVEYORS and CIVIL ENGINEERS.

ORGANIZED AT LANSING, MARCH 25, 1880.

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FIFTH ANNUAL MEETING

OF THE MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS, HELD AT EAST SAGINAW, JANUARY 1-4, 1884.

SECRETARY'S CONDENSED REPORT OF THE PROCEEDINGS.

The association assembled Tuesday, January 1, at 2 P. M., at East Saginaw, in the City Council Room, which had been kindly placed at their service, and was called to order by President J. B. Davis.

The following programme was submitted by the executive committee and was adopted:

PROGRAMME.

Tuesday, Jan. 1, 1884—2 *p. m.*

Report of Executive Committee.
Report of Committee on Manual.
Report of Secretary and Treasurer.
Drainage of Large Marshes—C. E. Hollister, Laingsburg.

7:30 *p. m.*

Address of welcome by Mayor of East Saginaw.
Address of President—Railroad Earthwork, Prof. J. B. Davis.
Highways—Wm. B. Sears, Chief Engineer F. & P. M. R. R.

Wednesday, Jan. 2, 1884—9 *a. m.*

Logging Railroads—H. M. Caukin, of Greenville.
The Narrow Gauge Railroad—A. L. Reed, Chief Engineer P. H. & N. W. R. R.

2 *p. m.*

Questions of Practice—I. H. Leavenworth, Saginaw City.
Temporary Railroad Bridges—George Masson, Chief Engineer D., G. H. & M. R. R.

7:30 *p. m.*

Water Works for Interior Cities—W. R. Coats, Engineer Kalamazoo City Water Works.

Thursday, Jan. 3, 1884—9 *a. m.*

Legislative Questions—Form of bill needed, A. L. Drew, Three Oaks.
Exhibits of Instruments by L. E. Gurley, of Troy, N. Y., and L. Beckmann, of Toledo, O.

2 *p. m.*

Construction of Small Steam Vessels—H. C. Pearsons, of Ferrysburg.
Address by Geo. H. Frost, of New York.

8 *p. m.*

Reception and Banquet at Marshall House.

Friday, Jan. 4, 7 *a. m.*

Excursion to points of interest in Saginaw and Bay City.

2 *p. m.*

Report of Committee on Exhibit of Instruments.

As many of the members in attendance would be obliged to leave the city before the close of the meeting, it was finally decided to give up the banquet and devote Thursday evening to the report of the Committee on Instruments and to miscellaneous business, leaving Friday entirely clear for the excursion. The President's address had for its subject Highway Bridges, in place of the announced topic of Earthwork. No copy has been furnished for publication. Mr. Caukins' paper on Logging Railroads was not presented, and Mr. Masson's paper was read, in his absence, by Professor Greene. With these exceptions the programme, as given above, was carried out.

The draft of a bill, by A. L. Drew, of Three Oaks, for submission to the Legislature, having in view the registration of surveyors, was read by the Secretary, ordered printed, and a copy sent to each member, with a request that suggestions and corrections should be returned to the committee on surveying. This committee was directed to report to the Executive Committee at a date not later than Oct. 1, and the latter committee is authorized to present the bill to the next Legislature.

The following changes in the Constitution and By-Laws were recommended by the Executive Committee and adopted by the Association:

CONSTITUTION.

SEC. I. to read as follows: Any person engaged or actively interested in engineering pursuits, in good standing in his profession, may become a member of this society by paying two dollars into the treasury: *Provided,* etc. (See present form).

SEC. II. to strike out the words "in each congressional district of this State."

BY-LAWS.

SEC. 6.—Standing committees consisting of three members shall be appointed by the Chair; their term of office shall be for one year, and their duty shall be to consider questions of interest to the society pertaining to their respective divisions. These committees shall also submit a list of subjects for the annual meeting to the executive committee by September first, of each year. Committees shall be appointed on Land, City, and Highway Surveying, Railroad and Bridge Engineering, Mechanical Engineering, Hydraulic and Mining Engineering, Sanitary and Drainage Engineering.

SEC. 7. The Secretary shall appoint at each meeting, to hold office during the meeting, a recording secretary.

The committees appointed by the chair will be found in the list of officers.

The Executive Committee was authorized to take into consideration a change of name for the Association more in harmony with the above changes in the constitution. NOTE.—The Executive Committee have since decided to change the Association's name to "The Michigan Engineering Society."

New Members.—Applications for membership, duly endorsed, acted on by the Executive Committee, and recommended by them, were received by the Association at different times during the meeting. By a special vote in each case the following new members were admitted:

Prof. M. E. Cooley, Ann Arbor.
W. R. Coats, Kalamazoo.
Johannus Kvan, East Saginaw.
Frank S. Hastings, St. Louis.
Frank F. Rogers, Marlette.
James E. Jopling, Ishpeming.
C. E. Mitchell, Ludington.
R. E. Williams, Jackson.
W. H. McEwan, Ionia.
Joseph Ripley, Sault Ste. Marie.
Seth Dean, Glenwood, Iowa.
D. K. Allington, East Saginaw.
Geo. L. Wells, St. Louis.
L. E. Gurley, Troy, N. Y.
G. W. Chandler, East Saginaw.
F. A. Rice, Bay City.
R. W. Roberts, East Saginaw.
L. Beckmann, Toledo, Ohio.
Wm. Grant, East Saginaw.
Geo. Freeman, Edenville.
Frank P. Davis, Jackson.
Geo. Marsh, Olivet.
C. A. Koehler, East Saginaw.
W. D. Arnold, Mt. Pleasant.
Andrew Wenzell, Detroit.
Geo. H. Frost, New York.
B. H. Muehle, Detroit.
Eugene F. Law, Marlette.

THE MANUAL.

The Committee on the Manual reported, through Mr. F. Hodgman, that, so far as original work was concerned, the manual was complete. On motion, the work of this committee was referred to an examining committee, consisting of D. Skeels, A. J. Teed, T. W. Pettee, the

President and the Secretary, with power to act for the association. Authority to print the manual, after its acceptance by the above committee, was conferred upon the executive committee. Mr. F. Hodgman was elected a delegate to the Ohio Association of Surveyors and Engineers, to secure its coöperation on the manual.

The contents of the manual or, as it is proposed to call it, Surveyors' Hand-book are, as planned by the committee:

1. Instruments and Adjustments.
2. Use of Compass, Level, Transit and Solar.
3. Areas.
4. Land Surveying—laws, decisions, etc.
5. Drainage Surveying.
6. Tables—logarithmic sines and tangents; natural sines and tangents; logarithms of numbers; traverse tables; trigonometrical formulæ; miscellaneous.

Officers, 1884.—The nominating committee, Messrs. Appleton, Bullock, and Hemingway, reported the following nominations:—For President, Professor J. B. Davis; Vice-President, Geo. E. Steele; Secretary and Treasurer, Professor R. C. Carpenter. The report was accepted and the ballot was cast by the Secretary.

The President appointed the standing committees given under the list of officers.

REPORT ON INSTRUMENTS.

The Committee on Exhibit of Instruments, Messrs. Rothwell, Bartholomew and Leavenworth, reported as follows and the report was adopted:

> Your committee have carefully looked over the collection of instruments submitted to their inspection, and would respectfully report that, where so many very fine and beautiful instruments, so thoroughly adapted to the work for which they are designed, are shown, it is very difficult to discriminate.
>
> Messrs. Buff & Berger, of Boston, Mass., show an exceedingly fine engineer's theodolite, admirably designed for railroad, city and triangulation surveying; also a mining transit which has some attachments and improvements recommending it to the profession for its peculiar class of work. Their surveyor's and engineer's plain transit is also an instrument of merit and well adapted to the uses of the profession.
>
> Messrs. W. and L. E. Gurley are prominent as designers of light and portable instruments, well adapted for use in mountainous regions, for preliminary work, and for work that requires considerable accuracy. On account of their number it is hardly practicable to mention them in detail; their mountain transits are already well known; their archi-

tect's and builder's level will supply a want that has long been felt, as will also their drainage level.

Mr. Beckmann, of Toledo, shows an excellent grade of engineer's transits and wye level.

Mr. Hobby's instruments have points that especially recommend them to the profession, and Mr. Hodgman's steel tapes leave nothing more to be desired as to quality and accuracy.

In the opinion of your committee the instrument makers are fully keeping up with the requirements of the profession, and your committee take pleasure in tendering them thanks for the great pains they have taken, not only in meeting the wants of engineers and surveyors, but also in exhibiting the merits of the various instruments here in friendly competition for patronage.

REMARKS OF L. E. GURLEY.

The manufacture of surveyors' instruments, has been conducted by our firm for nearly forty years. The business seemed at first to have little promise, and the receipt of an order for even a vernier compass, was, in early days, a cause of rejoicing. The sales of instruments in the first year were less than $400, and of course but few larger and costly ones were called for; but with the rapid development of the country, and the extension of the railway system, there has been a corresponding increase in the number, variety, and perfection of instruments required.

It has been our constant aim to keep pace with this growing demand, seeking to furnish the best article at the lowest living rate, and to adapt our instruments to the various needs of our patrons in every part of the country; and we have come here that we may better know the surveyors of Michigan and their peculiar requirements, discover where we have failed to meet their needs, and thus supply anything that has been overlooked in the past.

We are happy to find that those who have been our customers for more than thirty years are still our warm personal friends, and we may assure them that our facilities and ability to supply their needs have been more largely increased during the three years past, than for any similar period in our history.

We employ about 100 men, and our sales of instruments reach from $120,000 to $180,000 per year. These instruments are sent, not only to all parts of our country, but largely abroad, to various parts of the civilized world. We have now five automatic dividing machines of the very best construction, two engraving machines, and over 100 lathes—besides other tools of less importance—all employed in the manufacture of instruments for the surveyor and engineer.

We propose to improve our processes and products, that we may, even better than in the past, be able to supply our patrons with those implements which may help them to carry forward still farther the development of this country.

The various instruments exhibited by this firm were then described in detail, especially the "mountain transit," the drainage and architect levels,

and a great variety of pocket compasses, with sights, having sockets, and with verniers, for variations of the needle, limbs for angular readings, and fitted in some cases with telescope in addition to the usual sights.

The annual report of the Treasurer was received and referred to an auditing committee of three, Messrs. Hollister, Teed and Ripley, who in due time reported that all vouchers and accounts were correct.

ANNUAL REPORT OF TREASURER.

RECEIPTS.

Cash on hand January 9, 1883	$52.00	
Interest paid by Savings Bank, 1882	1.47	
Fees and dues paid at meeting, 1883	76.00	
Dues for 1883 paid since meeting	35.00	
Fees from new members	20.00	
Dues paid for 1884	6.00	
Deposits for reprint of reports	12.00	
Interest for 1883	1.80	$204.27

PAYMENTS.

As per vouchers submitted.

Expenses of manual committee	$13.35	
Cuts and postage on proceedings	23.38	
Postage and stationery	24.15	
Labor mailing	4.50	
Miscellaneous printing	20.00	
Ribbon badges	3.70	
Expenses of executive committee	20.00	$109.08
Cash in Treasury, January 1, 1884		$ 95.19

The auditing Committee have examined the above accounts and the vouchers pertaining thereto and find them correct.

C. E. HOLLISTER,
[SIGNED] A. J. TEED,
JOSEPH RIPLEY.

EAST SAGINAW, Jan. 2, 1884.

The relief fund remains as given by the last report; balance in hand $4.50.

A resolution was passed tendering $50 to the Secretary for his services the past year, but the compensation was declined with thanks by the Secretary.

Standing Resolutions.—The following resolutions, offered respectively by Mr. Hollister and Mr. Sears, were adopted:

Resolved, That our present system of making roads is utterly inefficient and unworthy of this State, and that we will use our best efforts to educate the people into demanding a better method and to point out what that method is.

Resolved, That the members of the association be requested, in

making village, city, or town plats, to record the dimensions of lots, blocks and streets in feet and decimals of a foot.

Future Meetings.—It was decided that the next annual meeting should be held at Lansing, February 17, 1885.

The question of a tri-State meeting of the members of the associations of Ohio, Indiana, and Michigan, to be held some time in August of each year, was discussed and received with favor. It was finally referred to the executive committee with power to act for the association after they shall learn the pleasure of the other State associations.

Courtesies Extended to the Association.—The various railroads entering East Saginaw granted the members reduced rates to and from the meeting.

The Flint & Pere Marquette Railroad had kindly tendered the association an excursion to Bay City over their line on the east side of the Saginaw River, and the Michigan Central Railroad had made the equally kind offer to draw the train back over its line on the west side of the river. The severe cold and deep snow of the week rendering the movement of trains uncertain, Superintendent Keeler, of the Flint & Pere Marquette Railroad, tendered the use of a special train to go and return over his road.

After some discussion his offer was accepted and a vote of thanks to the officers of the Michigan Central Railroad passed, declining their kind offer. It was decided to meet at 8 A. M., Friday morning, at the office of W. B. Sears, Chief Engineer Flint & Pere Marquette Railroad, and to place the association in his hands for the day.

Votes of thanks were passed to Superintendent Keeler and other officers of the Flint & Pere Marquette Railroad, also a resolution of thanks to the Council of East Saginaw for the use of their room without expense to the association.

The meeting adjourned Thursday evening, January 8.

Excursion, Jan. 4.—This feature of the fifth meeting will always be pleasantly recollected by those of the association who participated in it. Although the day was bitterly cold, yet under the auspices of Chief Engineer W. B. Sears, Road Master Geo. Brown, Assistant Engineer J. Kvan, Chairman of Local Committee E. F. Guild, and the resident members of our association, the rigors of the weather were forgotten. The day was spent as follows: An hour was devoted to an examination of drawings in the Chief Engineer's Office. At 9 A. M. the special train left for Bay City. At that point the members of the excursion were met by Member E. L. Dunbar, Superintendent of Water Works,

with a sufficient number of covered sleighs for the whole party. Under his guidance the party visited the manufactory of the Wyckoff wooden water pipe, the pumping works of Bay City, and one of the numerous salt blocks; then they proceeded across the river and examined the pumping works of West Bay City, which are in charge of Member Van Liew; from that point to the train, thence back to East Saginaw, the point of starting, where the members found awaiting them a generous lunch provided by the officers of the Flint & Pere Marquette Railroad.

The afternoon was spent in examining the extensive machine and car shops of the railroad. After resolutions of thanks to Mr. Sears, Mr. Brown, and Mr. Dunbar, the association adjourned *sine die*, feeling that the fifth meeting was the most satisfactory one ever held.

RESOLUTIONS OF RESPECT TO THE LATE FREDERIC H. HERBERT, PREPARED BY E. F. GUILD, AND A SKETCH OF HIS LIFE, BY CHARLES HOLMES.

Resolved, That in the death of our respected Brother Frederic H. Herbert, this Society has lost an efficient member, and the City of East Saginaw has been deprived of a capable engineer as well as a worthy citizen and member of society.

Resolved, That this Society tender to the wife, family and friends our heartfelt sympathy in their loss.

Resolved, That this Society publish in its proceedings the following notice of his life and the Secretary transmit a copy of these resolutions and obituary notice to his family.

Mr. Frederic H. Herbert, a member of this association, one of the most industrious, and certainly not the least meritorious of engineers of this State, died suddenly on the 20th of November last, at his residence in this city, at the age of fifty-seven.

He was born and educated in the city of London, England, where he served an apprenticeship with a land surveyor and lithographer. In early manhood he removed to the city of New York, where he first entered the employ of Endicott & Co., lithographers, and subsequently that of the late John J. Terrell, one of the city surveyors. Mr. Herbert was much admired for his gifts as a draughtsman and lithographer, and, during the thirteen years of his practice in New York, acquired the reputation of being a good authority on all matters pertaining to cadastral surveying and sanitary engineering.

He has been secretary and engineer to the Board of Sewer Commissioners, of East Saginaw, since its first organization in 1866 and at the time of his death was engaged on sewer construction. During the existence of a partnership with Charles Holmes he was also appointed City Surveyor for six consecutive years. In the death of Mr. Herbert a good and honest man has gone. By the few who enjoyed the pleasure of his intimate acquaintance he was beloved for his gentle, modest and sympathetic character, as much as he was admired by a wide circle in his public capacity, for his abilities, and the rare fidelity with which he discharged every duty. What more can be said.

MAYOR'S ADDRESS.

Mr. President, and Members of the Michigan Society of Surveyors and Civil Engineers:

As mayor of the City of East Saginaw, I desire to extend to you the welcome of its citizens, and in doing so I deem it a pleasure to have the honor to thus open the New Year in our young and growing city with a convention so important to its people and the people of this State as the one you have here assembled.

Gentlemen, your organization is a good one, and while you have thus banded yourselves together for your mutual advancement and improvement in your profession, there is no question which you may discuss, or knotty problem you may solve to your own satisfaction, but will be of more benefit to the community at large than to any of you individually.

The profession that you have chosen is one of the most honorable of all the business professions; and to be a successful surveyor or civil engineer is a position that any man may well feel proud of. Gentlemen, I cannot help but think that the American people as a class are proud of the work and skill of their surveyors and civil engineers. And why should they not be? See what they have done in the last ten years. The hardy surveyor, with his corps of faithful assistants has crossed and re-crossed this continent, surveying miles and miles of railroad; and the civil engineer has followed in his tracks building stupendous bridges and trestle-works, overcoming obstacles which, to an ordinary person, would seem impossible. All this, that the iron horse might travel the track thus laid out by them, carrying with safety thousands of passengers and millions of property, with pride and profit to the projectors.

I cannot help but relate to you a circumstance that happened a short time since, and which I think is quite applicable: A friend of mine who was visiting at my house was relating his visit to Niagara Falls, and said to me that, as he stood looking at the Falls he could not help but think how wonderful and great is the handiwork of God; and then as he turned and looked at the suspension bridge spanning the mighty river, he said, how wonderful and great is the handiwork of man. The comparison was so sublime and made such an impression on my mind that it will never leave it.

Gentlemen, you are doing a good work in thus giving to the world and more particularly in giving free gratis to the young surveyor and civil engineer starting in life, what has cost you years of study, labor

and toil. And I certainly hope you will reap some reward in the good work you are doing.

Finally, gentlemen, in conclusion, I hope during your short stay in our city that nothing will occur to mar your pleasure or your business; and that your Fifth Annual Meeting will prove a success. And I certainly wish you one and all a "Happy New Year."

DRAINAGE OF LARGE MARSHES.

By C. E. HOLLISTER, of Laingsburg.

Marshes are not alike in all features, nor in the ease and manner of their drainage. Those lying nearly level with the great lakes would probably have to be diked and pumped out. But land in Michigan is as yet too cheap to warrant resorting to such an expensive process, and we will therefore omit all this class of swamps, and leave them to the engineer of the future.

The northern part of this peninsula was probably once an island, separated from the main land by a broad strait, extending from Saginaw Bay westerly through the region now known as the Saginaw and Grand River Valleys. This portion of Michigan is still low, and the country between the Saginaw and Grand Rivers, in Gratiot County, is perhaps the lowest point in the water-shed dividing the eastern and western slopes of the State. As this region is some 80 or 90 miles from either Lake Huron or Michigan, the water-courses have little slope, actually showing at some portions of their course, at a moderate stage, no fall in the surface of the water for one or several consecutive miles, and at other times having for 10, 15, or 20 miles no more than 10 to 14 inches fall per mile. Their channels are very tortuous, with many a needless mile through marshes and swamps.

Either the river channel must be deepened or the banks leveed and the marshes drained by pumping. Fortunately the former is much the cheaper in first cost, to say nothing of maintenance.

The problem in such cases is not so much what to do or how to do it, as it is to raise the necessary funds for the work. The present owners are not rich; had they been they would have bought upland; they have no idea that the land will be worth anything if drained, and the work requires a large expenditure all along the line, to which they will never agree except in the case of small streams of say 20 feet in width. The larger streams require some other than the common proceedings under the drain law.

It needs no argument nor any unusual experience to set forth the unhealthfulness of this state of repeated overflow and evaporation under the summer sun. But it seems that argument and facts and long continued agitation may be necessary to convince the people of the State that they can afford to deepen these river channels, and that a just consideration for the health and lives of those living near such streams will warrant the expenditure and demands the assistance of the State in aiding and urging on this work.

In two noteworthy instances, the deepening and straightening of small streams preparatory to draining the large areas of wet land along

their courses have been begun and carried nearly to completion in Clinton County, under the drain law, J. N. Smith as County Drain Commissioner planning and directing the work. The South Maple, or south branch of the Maple has its source in a pond on sec. 16, T. 6 N., R. 1 W.; finds its way without much channel in a southerly direction through wide marshes for about 2 miles, then makes a sweep east and then northerly to the Maple River on section 4 of T. 7 N., R. 1 W. At the point where it turns east it is about 1 mile from the Looking-glass River, which at that point flows west in wide marshes.

Marsh land extends continuously from the creek to the river and drains into both. It is a noteworthy fact that, if the creek is cut to the depth of 5 feet from the surface of the marsh and a branch extended to the Looking-glass River, it will bring water from the channel of the latter river through the creek into Maple River. The creek drains about one-third of the Town of Victor, and about half of Ovid Township. In some places it flows through a narrow bottom or swale only a few rods wide, but most of the way through marshes or elm swamps ½ to ¾ mile wide, the main line being about 17 miles long, and having two branches one about 4, the other about 2 miles long, laid out and dug at the same time.

From the mouth of the creek for a distance of 5 miles the bottom as dug is to be 12 feet wide, and is to be deepened gradually as the valley widens until a depth of 5 feet from the surface is attained. At this point the drainage of about a square mile of marsh and the adjacent highlands enters the creek. Above this place the bottom is narrowed to 8 feet. About four miles up the stream is another branch of some miles in length. Here again the width at the bottom is contracted to 4 feet. At a point about 4 miles further up stream another branch comes in and the width beyond is again reduced to 2 feet on the bottom. The whole elevation from Maple River to Cedar Lake is about 95 feet.

It was proposed to make the bottom of drain 4 feet below the surface of the water at the stage when the preliminary survey was made, but the square mile of marsh that drains into it lies so flat that it was necessary to increase the depth to 5 feet. The work was put under contract in August, 1882, and most of the work was done by Jan. 1, 1883. The people along the line were amazed at the idea of going so deep, and thought it unnecessary; now they wish the ditch were deeper.

The cost was $13,000, and the number of acres of wet land which is assessed for benefit is about 3,300, making the cost about $4 per acre were it all to come from this land. About $3,000, however, were assessed to the two towns through which it ran, for benefits to health and highway benefits.

The very remarkable fall in this stream comes from its running north and towards the low part of the State mentioned before. The Cedar River empties into the Grand at Lansing, the Looking-glass at Portland, and the Maple at Lyons. All rise near together and flow nearly west. If then we cross a little west of the meridian, we find the Cedar about 25 feet higher than the Looking-glass, and the Maple about 120 feet below the Looking-glass.

We find still another class of marshes, such as the Chandler Marsh—large, flat; no creek flowing through them, but usually a creek leading from or heading in them. Usually the outlet is level for a long distance, so that we have a flat perhaps 4 or 5 miles long, sometimes double that, and we find that a large expense must be incurred in opening an outlet before we can begin to drain the marsh. When the water is drawn out, such marshes will settle from 1 to 2 feet. The Chandler Marsh has settled so that large stones project a foot, where in a natural state, all was water and soft mud, and no one thought of finding a stone within half a mile. The farther down the stream from the marsh, the shallower is the muck, the firmer the ground, and the less it will settle.

In making our calculations, we must, to save expense, go no farther down the stream than necessary; we must lay the grade as flat as will work well, and go no deeper than necessary. Conditions have operated so powerfully upon parties in charge of such works, in all the cases which have come to my knowledge, as to over-shadow other less obvious but equally important matters, and have spoiled the job, making it necessary to go all over the same work time and again. Yet if we know and state just what is necessary, we often cannot get our plans adopted, because they look too large.

1. We must allow for the settlement of such marshes and the derangment of our grade. Hence we must cut deeper below and go farther down stream than at first seems necessary. *All fail here.*

2. We must go deep enough to allow the marsh to settle and still be able to drain the further edges of the marsh to a depth of 3 feet with a proper grade to the outlet.

3. The outlet must be large enough to carry the water off freely. We must look up the local water-sheds and see how much water we have to provide an outlet for.

The Perrin Marsh, in the Town of Greenbush, Clinton County, is a case in point. For some years they raised quite good crops on the marsh, until the neighbors saw that marshes could be made productive, and had ditches dug running back 1 or 2 miles on each side, but especially on the south. As this is south of the low part of the peninsula, the surface slopes rapidly to the north. These side ditches have a great fall and flood the marsh by bringing the water in too fast for outlet to carry it off. It also was not dug far enough down the stream. South of St. Johns is a similar case which fails for both these reasons, so that the man who was really the pioneer in reclaiming the marsh is completely drowned out and has lost his entire crop for two years on land where, before that time, he had raised most spring crops, hay and onions.

The Chandler Marsh also has no outlet. The main ditch stands full of water, as any of you who cross it on the J. L. & S. R. R. may see. Of course nothing can be done with land when the water stands in the ditches at a level with the surface.

The water which falls on a marsh is not that which makes the greatest trouble in draining them. It is that which flows on from the surrounding and higher lands and also that which passes through the soil from the up-

lands whether it comes in the form of springs, or by an almost imperceptible soaking through the soil. If we run a branch on each side of the large marshes, we shall cut off all this water which comes from the sides. Otherwise it will flow over the surface and keep the whole marsh wet. This water may be drawn in by laterals, and, in small marshes, with but narrow water-shed on the sides, this is the wiser course, but where a wide marsh is surrounded by a wide strip of flat land, we shall succeed better if we run near the edges of the marsh and drain from each side of each ditch with laterals.

Some will object to this view, and say that the middle of the marsh will settle most and hence be too low to drain into the side ditches. In fact, however, the middle of a marsh is generally the highest and can settle most and yet not be too low; but the main reason after all is, there must be a drain along each edge to catch the soakage, or we shall not have it drained; and the cost will be less than to first make a main through the middle, and then laterals and shore drains. If the marsh is wide, the length of the laterals to bring in the shore water, especially if branch drains are needed as often as one in 40 rods, will be greater than the excess of the shore lines over a main in the centre.

DISCUSSION.

MR. J. J. WATKINS—Did not believe that the bottom of a ditch settles; can see no reason for it, and his experience has proved that the top settles and the bottom rises, so that the ditch gets shallower from two causes. Use an 8-rod tape and give distances in rods and links; commissioners liked it better.

MR. S. N. BEDEN—Was certain Mr. Hollister was correct; had tested the bottom many times by reference to a fixed bench mark; in one case when the levels had first been run by another party and ditch constructed from these levels, he had occasion to run the levels again and found a perfect agreement with the first levels on hard land, but on the marsh the result showed either an error of the first party, or that the ditch had settled 12 or 14 inches; believed that the bottom of the ditch had settled; put grade stakes down to grade; there can be no mistake, and they remain in the ditch to show the position of the bottom for all time; get them down by driving with a sledge on a turned and graduated hickory stick, with ferule to prevent splitting; no difficulty in getting them down 4 or 5 feet; consider a grade of 1.6 feet per mile as small as should be used; object to less than .06 foot per 100 feet.

MR. W. B. SEARS—Thought a better plan was to leave the top of each grade stake 3 or 4 feet above the grade line.

MR. M. W. BULLOCK—Would like to know of a small dredge for such work; has had much difficulty with a floating bog; finally conquered it by constructing a flume in sections and sinking each one to place; prefer to drain small marshes by a centre ditch.

MR. B. F. WELLES—Said that underneath the City of Marshall was a layer of sandstone so porous and dry that it would serve as an outlet to marshes if connected. In one case 10 drive wells in an area of 10 acres removed 10 inches of water in two days.

MR. HODGMAN—In some cases drive wells let water up instead of down; it depends entirely on the underlying strata. Many are dissatisfied with drainage because it is only half done; drainage might as well not be commenced as to be only half completed; had seen drains with a large volume of water work well on a level; get all the fall possible; thought that in marshes underlaid with clay the bottom would rise, and in deep muck marshes it would settle.

Mr. W. APPLETON—Thought that the well method of drainage would always work if the well was made deep enough; had tried it with good success himself and the well worked well for four or five years; he filled the well with small stone, but in time the silt from the marsh washed among them and ruined the well by filling the pores.

PROFESSOR J. B. DAVIS—Suggested that the well be made large, and that it be made deep enough so that it should extend some distance into the water taking strata so as to get a side outlet; a settling well or basin should first receive the water and discharge from its upper surface into the drainage well.

MR. T. W. PETTEE—Generally set stakes once in 20 rods, some commissioners prefer a grade table to a profile; must one be made? (The law requires one).

MR. C. E. HOLLISTER—Believes in putting the drains on the edge of the marshes and not through the centre; the water that does the injury comes almost invariably from the uplands; would have them far enough from the edge of the marsh to allow the velocity of the water from the banks to be checked sufficiently to deposit debris before reaching the ditch. Clinton County has spent about $60,000 on county ditches the past year, but the principal construction has been done by hand. The cost for a ditch with an average depth of 5 feet, bottom width 8 feet, top width 24 feet, has been $5 per rod. The best results were obtained when each man could be induced to take the contract on his own land; had much difficulty with floating bogs. It is impossible to dig them out, when soaked with water; have had good success in freezing weather, by digging but little faster than the muck would freeze; the least grade depends on volume of water; for ordinary ditches should be 1 foot per mile.

ROADS AND ROAD-MAKING.

By W. B. SEARS, of East Saginaw.

What "I don't know about earthwork" would fill a very large volume. My name and the subject you wished me discuss were introduced without my consent, and as my strength is limited and time fully occupied, all I can do at the present time is to give a few general hints on roads and road-making. My first observations and lessons on earth-work carry me back forty years to the highways in the hilly portion of Ohio, southwest of Zanesville, where as a boy ten to twelve years of age, armed with a garden hoe, shovel or mattock, I saw the farmers and their sons marshalled under the road supervisor of the district, once annually, to work the roads, "make the rough places smooth and passable." The boys in the gang *worked hard* catching butterflies, wrestling, killing snakes and toting water. The men were discussing politics, instructing the supervisor how to do the work, and part of the time playing with the boys!

A gang of twenty to forty men and boys accomplished about as much effective work as one-fourth of the number should have done, if armed with suitable tools, and directed by a competent man who understood road-making. Judging from the condition of the highways in large sections of our State, this system of periodical holiday work is still maintained. It is a good system to develop cranks and loafers, and roads maintained under it are good enough for this class of men to travel. But a majority of us are better men and more deserving; we are in haste to reach the town and the market, to hurry home again to resume some useful work, to economize time, and therefore demand a better system. Mr. Kent, of Adrian, gave us a good article on "Common Roads" at the last meeting, and the remedies suggested are excellent. The repairs should, he says, "be the work of the season, a careful supervision being constantly kept over the whole system, and repairs made as often as they are required." Let us all labor to hasten the day when something like a system may be organized for the skillful and economical construction and maintenance of our common roads, the most indispensable and useful agents constructed by civilized man. The interests of all men are promoted by the construction of good roads; and to make them cheaply in the Saginaw Valley and other flat portions of the State where gravel and stone are wanting, and have to be transported long distances, I venture a few suggestions for your consideration and discussion. The old paths through the woods, made of corduroy across the swamps and all low wet lands, are practically impassable with loaded wagons for half the season. The few plank roads in the country, which were made from timber standing on the roadway and along its line, are nearly all worn out and abandoned. The timber for

renewing them is consumed in many localities where they are most wanted, and you are practically without roads; they are *mud-ways*, breeding grounds for vile things, snakes, frogs, musquitoes, foul weeds, malaria and death. A ride over them on a quiet Sabbath day in the months of April and May, what a pleasure! and what pleasant reflections and sayings are called forth. Concealed in the brush alongside of one of these "sloughs of despond," listen—you might perchance hear a Presbyterian deacon swear. What time have you, with your sweetheart beside you, to talk of love and flowers, a beautiful home, the comforts of home, and all that makes home pleasant and valuable? Who wants a home that you cannot approach with ease, comfort and dispatch? Nobody, but savages, barbarous men and animals. You cannot build up good homes—at least, they are not desirable, without good roads to approach them. Hence, good roads are the first thing needful to advance the common interests of a growing people. How shall we make them in the Saginaw Valley? I promised a suggestion.

In the first place I would select the leading road connecting a thriving country town with the city, along the line of which was located the largest and best equipped population to pay for the improvement. I would clear, grade, ditch, bridge and thoroughly drain this road, making the cross section of it of the best possible shape to receive a heavy coat of gravel or broken stone, forming the base for a good turnpike or gravel road. Excuse me if I keep repeating the first requisite for all road making. Forty years' close observation of roads has shown me clearly (and I think every keen, practical observer has noted the same fact), that a drained road bed will stand a heavy traffic with slight and regular repairs; whereas an undrained road is worthless, and does not deserve the name.

From June to October some undrained roads are passable for light traffic, if the dry weather lasts long enough to wear down the ridges, lumps and hummocks which are always thrown up by moderate usage in soft, wet weather; and again in winter for about two months, if the ground should be frozen solid after the hummocks are worn down and the ruts filled with snow and ice, they are fair sled roads for a brief season, as long as this remains.

When most wanted for general traffic, April to June and October to January, in this latitude, they are comparatively worthless. Now, gentlemen, drainage is the only cure, and while I would advocate ample side ditches, with uniform grades descending toward the natural water courses intersected, open ditches along roadsides in a flat country are a miserable make-shift for permanent drains. They will aid and are necessary to carry off the water from heavy storms, and the wasting snow and ice in the early spring, but they catch all light, floating matter. Animals in passing mix it up, tramp over, obstruct and destroy them. To be efficient and serviceable in a flat country, where the grade is slight, they should be mowed, raked and cleaned annually, and two or three annual cleanings, if well done, would pay for and place good tile drains in these same ditches on a lower plane. I would, therefore, place suitable tile drains two and a half or three feet below the bottom of the ditch, or four to five feet below

the crown of the road-bed, and these tiles should be of sufficient capacity, when necessary and expedient, to take lateral drains from the adjacent fields of the farmer. Place in this system of tile drains, at proper intervals, silt basins, well constructed, so as to be cheaply maintained. Also wells at the outlets, with suitable grates and screens to protect them. Keep out of the drains everything but water, and I'll guarantee it to keep moving if you will provide the least show of descent. For small drains three inches fall to the hundred feet is ample; for large drains half this fall will do the work well.

We now have our road ready to receive the road metal. What shall it be? Stone or gravel? We use both where they can be obtained. How shall we obtain them? Use the railroads already constructed, nearly all of which pass through, or near, good gravel beds, to transport your material. Branch off from the railroad where your proposed highway intersects it; lay down a temporary track along the line of your graded road-bed, and distribute the stone and gravel for its formation just as you would ballast a newly-constructed railroad track. Unload enough at one-fourth and one-half mile stations for contemplated repairs, and where cross-roads intersect your main line deposit material enough to gravel a mile, or more, of lateral road. Grade and drain your lateral as suggested for the main line, and distribute the gravel by the use of dump cars hauled by horses over a light and temporary rail track, in fact, a light railroad. When material for the main line and laterals is distributed, begin at the extreme ends of the system, take up your railroad track and move the plant to a new field of operations. Without a little study and reflection this plan might appear expensive and impracticable, but I think it the only feasible and economical mode for securing good roads in flat districts of the State, where stone and gravel are wanting and the haul is great. Railroads are now equipped with steam excavators for loading cars. They unload by machinery, moving gravel and earth long distances for completing embankments where temporary trestles have been in use, and this work is done for eight to ten cents per cubic yard. Add to this a fair cost for transporting your gravel 20 to 50 miles. As the railroad companies are mutually interested with the public in any improvement that will cheapen production, add to the value of lands and multiply the population of the districts tributary to their roads, is it not fair to assume that counties and corporations can secure freights at about the actual cost of doing the work?

I had supposed this method of road-making was original with me—until Saturday last, when accidentally taking up the *Surveying and Building News* of December 15, 1883, I read as follows: "Improving Country Roads—Vigo and Park counties have set an excellent example to other counties in this State in the matter of grading their country roads. To William R. McKeen, President of the Vandalia Road, much of the credit for such improvement is due. He proposed to haul gravel from gravel banks on their road to the most convenient point for the farmers to unload it, at the actual cost of transportation. He was among the first to encourage such enterprise, and miles of road were thus improved; in other parts of

the county, not accessible to this road, the graveling of roads has been carried on liberally, and unquestionably Vigo county is in excellent position in this respect. If the roads throughout the country are good the farmers can come to town at all seasons, regardless of the weather; but if the roads are bad they must remain at home until nature favors travel. If all over this State and Illinois taxpayers would cease to vote two per cent. taxes to new railroad enterprises, and vote aid to graveling their country roads, the value received for their tax would be much more apparent. In the northern part of the State some of the townships have shown commendable zeal of late in this matter, and it is to be hoped that all will soon fall into line. The present law seems to be all that could be desired on the subject. Good roads are cheaper in the long run than bad ones, and if the farmers once had them they would wonder how in the world they existed so long without them. C. E. Henderson, General Manager of the Indiana, Bloomington & Western, is urging business men on their system in Illinois to take hold of this matter, and offers to haul gravel at actual cost of transportation, giving parties the privilege of loading and unloading the cars, and railroad men generally show a disposition to encourage all improvements of this character, as the farmers, the business men in town and the railroad will be mutually benefitted."—*Indianapolis Journal.*

Now, my friends, the work is already begun, supplying a narrow belt adjacent to the railroads, and my method of laying down the temporary railroad in flat districts completes the system and supplies all your wants.

As advertised on your programme, gentlemen, I have said very little about *earth-work*, and am not prepared to do so on this occasion. My engagements have been such that I could not possibly take the necessary time to do the subject justice. I have seen great waste, and many expensive failures, where the axis of a road passed along steep hillsides, intersected by deep gulches, or ravines.

The important feature in building embankments, like all other works where permanence and durability is sought for, is *the foundation*. Fit the surface to receive your bank, and drain it thoroughly; carry on the earth in layers of three to six feet, keeping flush with the slopes, and make these layers a little the highest on the outside, so that the earth will have a tendency to settle toward instead of from the centre of your bank; cart or haul over these layers continuously, so as to consolidate the mass as much as possible. This is an expensive method, but the only one I have ever tried that gave satisfaction in bad localities, where care was necessary.

NOTES ON THE CONSTRUCTION AND EQUIPMENT OF NARROW-GAUGE RAILWAYS.

By A. L. REED, Chief Engineer P. H. & N. W. R. R., Port Huron.

When asked by the committee to prepare a paper on narrow-gauge railways I consented; but, on looking over the subject, I find so little to be said, except as to cost, that will not apply equally well to any railway, that I will simply note a few points on their construction and equipment in general, and then give you, somewhat in detail, the various items of cost particularly applicable to narrow-gauge roads, hoping they may be at least interesting to the members of the association, though I do not think they will be particularly instructive to those whose experience is largely in railroad work.

Location.—The question of location I need not allude to except to refer you to the able paper on the subject read by Mr. Hodgman at your last meeting. His treatment applies as well to roads of one gauge as another. I will say, however, that curves and grades on narrow-gauge roads are just as objectionable as on any road; although sharper curves may be used they should be avoided as much as possible.

Supposing our location to be completed and grades established we are ready to proceed with construction work; we will also suppose that the contract is drawn in proper form and the work let, subject to the proper specifications, as we are dealing more directly with the work of the engineer and the contractor.

Clearing and Grubbing.—The first work to be done is the clearing of the right of way and grubbing for the road bed; clearing should be done the full width of the right of way, whatever that may be, and all the logs, brush, and perishable matter be piled and burned, so as to be out of the way of the workmen as well as the contractor; as instances have been known where contractors have been tempted at least to use the logs, stumps, etc., lying along the right of way, for making the road-bed, which is not desirable except in special cases. The engineer should furnish the contractor, for use in clearing, notes of stations between which grubbing should be done, and width of grubbing, so that he may do no useless work and may do grubbing in connection with clearing, as a standing tree is much easier to grub out than a stump. All stumps and grubs should be taken out where the sub-grade line is within two feet of the surface, also on all cuts. Where the fill exceeds two feet low chopping will suffice, and in fills of four or more feet stumps of ordinary height are not very objectionable and may be left standing, except where they are very large and decayed, when they should be removed.

Cross-Sectioning.– Clearing and grubbing completed, the engineer is ready to do his cross-section work, which consists in putting in stakes every 100 feet, or oftener if the surface of the ground is uneven, which stakes are set one in the centre and one at the edge of each slope. Each stake should be plainly marked on one side with the number of the station at which it stands, and on the other with the cut or fill to sub-grade at the point where it stands. They should be set uniformly, the centre stakes exactly on the centre line, with the station number facing the backward direction of the line, and the slope or side stakes set at right angles to the line even with the centre stakes, with the cut or fill facing the line. On uneven ground plus or partial stations should be put in in the same manner as the regular stations, and the full station number should be put on each plus stake; thus a cross-section midway between stations 79 and 80 should be marked not simply +50 but 79+50. A little care in this direction will save a great deal of annoyance and time in subseqnent work when stakes are knocked down by careless workmen and have to be replaced, possibly when the notes are not at hand. At every point where the grade and surface lines cross there should be set a *grade stake* marked 0.0 or grade; this should be done not only at the centre but on each slope, and the plus station at which each occurs carefully noted.

Each cross-section should be carefully recorded in a cross-section book: the usual form being to place the centre cut or fill in a central column, and left and right slopes in a column at left and right of the centre in the form of fractions, with the cut or fill as the numerator, and the distance out from the centre line as the denominator, with their respective signs, plus for cut and minus for fill, thus:

L.	*C.*	*R.*
$\frac{-2.0}{9.0}$	+3.5	$\frac{+3.6}{13.4}$

showing a cut of 3.5 at the centre, a cut of 3.6, and a distance out of 13.4 on the right and a fill of 2.0 with a distance out of 9.0 on the left. These distances apply to a road-bed of 12 feet on fills and 16 in cuttings with a slope of 1½ to 1.

Experience has proved that there is no economy in building narrow road-beds. We commenced on the Port Huron and Northwestern Railway by making fills 8 feet at sub-grade and cuts 12 feet; then we widened banks to 9 feet; on our next work we made banks 10 feet and cuts 14, and now build banks 12 feet and cuttings 16 feet, which are none too wide, and are found to be more economical in the end.

As I believe the papers which are read from time to time before this association are intended to be of practical use to the members, rather than finished literary or scientific productions, let me give what I consider the best method of doing cross-section work. I have noticed that beginners almost universally use the cumbrous method of figuring out each station by itself from the height of instrument and grade height, a tedious as well as unnecessary work. First, set your level firmly and in such a position as to command a good view of your work; bring it to a level and take from the nearest bench mark a reading, which add to your

bench height to give you the height of instrument. Now, from your cross-section book note the grade of the station at which you propose to commence your work. The difference between your instrument height and grade height will be the reading of your rod at that station held at grade, and the difference between it and the actual reading at the point will be the cut or fill at that point.

To illustrate: Your bench-height is 80.10; your rod on bench mark reads 5.08, making height of instrument 85.18; your grade height at station 79 is 82.00; so your rod held at grade at station 79 should read 3.18. But suppose it actually reads 5.30; then your fill is 2.12: if it reads less than 3.18 you have a cut. If you are working on a a level grade all your grade readings will be the same and you have no trouble; but if, for example, you are working on a down-grade of 26.4 feet per mile, add to your rod 0.5 for each station, which would give you 3.68 at station 80, and the difference between that and the actual reading will give you the cut or fill. Then you can keep on adding to or subtracting from your rod reading at grade the change for each station, and work from rod readings at grade entirely, paying no attention whatever to your height of instrument or grade height until ready to move your instrument, when you begin over again. In this way one can soon become so familiar with the work that he can call off and record his work as fast as a rodman and two smart men can measure the distances, mark and drive the stakes.

In cross sectioning at changes of grades, especially when the changes are abrupt, vertical curves should be put in, extending from 1 to 3 or 400 feet each way, so as to avoid bringing the connecting grades to a point. This introduction of vertical curves is very little extra trouble in connection with the other work and should not be neglected. It is also advisable, though not a necessity, to put in at each regular station, where fills are to be made from side ditches, *berm stakes* the specified distance out from the slope stakes, as workmen are less liable to cut away the berm if stakes are driven for them to work to.

Earthwork.—Cross-sectioning being done at any given point the work of grading may be commenced. I have known of grading being begun without any cross-section work or even the centre stakes being in, but cannot say it was a success. Fills should be made from the adjoining excavations within an economical distance for hauling, which distance varies with circumstances. The embankment should be carried up uniformly from the bottom from full width, so as to prevent sliding or uneven settling. Fills made from cuts by the use of dump-cars can be carried up uniformly by shifting the track as may be required: where fills are made from side ditches the latter should be taken out continuously so as to make clear water-ways where necessary. The usual slope given to ordinary earthwork of sand, clay, or loam, is 1½ feet horizontal to 1 foot vertical, although varying circumstances may make a greater or less slope desirable. In cuts the slopes should be smoothly dressed and uniform; in each cut, however small, there should be side ditches to carry off the rain-

water, or that which soaks in from the sides; the ditches should have a surface width of one-half the difference of the width of cut and fill at sub-grade, leaving, as it were, an embankment through the cut, so that, when the earthwork is completed, the grade presents an unbroken surface of uniform width. It is not always advisable during the process of construction to take out cuts to the full width, or even down to sub-grade; when the material may be used for ballast the cut may be *gulleted* or taken out just wide enough to admit the passage of a train, and with slopes of ½ to 1, or even steeper, if the material will allow, and the remainder of the cut taken out with trains. In certain cases it is advisable to build narrow banks at first, to be widened later on.

Across all swamps and marshes soundings should be taken to determine the nature of the ground and the depth to firm bottom, and, in case the foundation is not good, some means should be taken to improve it. Where it is not too soft or too deep a good method is to corduroy with timber laid cross-wise of the road-bed with brush thrown on; the length of the timber necessary may be judged from the nature of the ground and the weight of embankment to be built. In some cases it is necessary to drive long piling, and some swamps are so deep that it is almost impossible to build across them with any reasonable expense; such places should be avoided if possible. Across some swamps and marshes very little or even no material may be obtainable to make a bank. I have recently, in my own experience, met with a swamp 2¼ miles across, which was, in the direction of the line, a level surface; soundings showed a firm bottom 6 to 18 feet below a fairly firm muck; but the season was very wet and an attempt to throw up a bank of muck was a failure, as it would run off a shovel before it could be thrown up. In this case I took the small poles and brush from the right of way and laid them along the center line cross-wise, and then some small poles, from 2 to 6 inches in diameter, lengthwise, so that they would come under the ties outside the rail; on these I laid the ties and iron for a good share of the distance across the swamp, with no earthwork whatever. After the track was laid across (it was not very smooth however), we turned back and filled with clay and raised the track; soon it will be one of the best pieces of track on the road.

Culverts.—During the process of locating and constructing, the engineer has looked over his line and its contiguous territory closely, to determine the location, size, and character of the necessary water-ways, and during his cross-section work has probably staked out his drains, culverts, and bridges, made out his timber bills, and made provision for the timber and material for the various structures. In places where there is but a small area of surface drainage, and no danger of an accumulation of water, a small drain of sewer-pipe may be made, or in cases where cheapness of construction is necessary, which too often happens, a simple box of plank, spiked together, will answer where the embankment is light. Where there is much water a culvert should be put in. On new work in new countries wood is almost entirely used, leaving the more expensive as well as more desirable stone and iron structures to be put in

when the first have had their day, and the other can be brought to the spot by train, and the company have presumably more means to do work with.

Ordinary culverts are built of 12″ × 12″ timber; I use 10″ × 12″ on edge, the sticks laid one upon the other, secured by dowel pins. The foundations are usually ordinary mudsills of flatted timber, sunk in the ground below the bottom of the waterway, to avoid undermining. The sills should be boxed down at the ends for a couple of inches to prevent the wall sticks from sliding in from the pressure of earth behind them. The top wall piece of an open culvert should be 4 feet longer than the width of embankment of sub-grade, and each succeeding stick 3 feet longer than the one above it till the surface of the ground is reached. The walls should be braced against the thrust of the earth behind them by struts across from one wall to the other, usually dove-tailed into the wall sticks. Culverts should be laid out so as to have the top of the walls reach just to sub-grade; on these walls are laid the track-stringers, lying loose so as to be brought to the required line or shifted at any time. When open culverts are more than 8 feet wide they should be made with a bridge top, i. e., with ties across the stringers. Box culverts are made as above described, but are covered with either plank or timber, and usually with the earth of the fill. Across small streams the ordinary pile bridge is the cheapest and best to build. Use white oak piles, not less than 10 inches in diameter at the small end, well driven; the usual plan has 4 piles in a bent, the bents from 12 to 16 feet apart (14 feet is a good distance), the piles sawed squarely off and the cap securely drift-bolted on top of the piles. Where the height does not exceed 12 or 15 feet the piles may answer as bents, and the track-stringers be laid directly on the caps; but where the height is greater there should be trestle-work on top of piles. Across larger streams, or where there is danger of freshets, ice, driftwood or logs, there should be a clear span to leave the channel unobstructed; on navigable streams a draw-bridge becomes necessary. For ordinary trestle work, timber of the following sizes may be used: Caps 10 × 12, main posts 10 × 10, batter posts 8 × 10, stringers 7 × 14, lateral braces 6 × 6, sway braces 3 × 10, girts 6 × 6, ties 6 × 8, guard rail 6 × 6. These dimensions will suffice for narrow-gauge roads using engines of 18 to 20 tons weight; we have latterly built our bridges of the usual standard size.

Track-laying.—In advance of track-laying the engineer should carefully retrace his line along the grade and put in solid stakes for track centres; these stakes should not be less than 2 inches square, well driven left 6 to 8 inches above the surface of the grade, and having a tack or nail showing the exact line on the stake. On tangents centre stakes 200 feet apart will suffice, but on curves they should be put in every 50 feet. Centres should be put on all culverts, and, at intervals of 10 to 20 feet, on all bridges. We will now suppose the centres in, the material all ready, our forces and construction trains at hand, and will proceed with work. First, we must load one train with the proper proportion of iron, ties, bolts, straps, spikes, and tools; the car for bolts, straps, spikes, etc., is usually the head car; then come the ties, then the iron. The train is

backed out to the end of the iron, and when the track-laying force is ready as many rails and ties as will make a lorry load are thrown off together with the necessary spikes, bolts, and straps, and the train pulls ahead out of the way. The lorry-men run their car back and load, say, ten rails; above the rails, but placed so as to leave the rails loose, are loaded a sufficient number of ties for as much track as the rails will lay, and bolts, spikes, and straps enough for ten joints. Then the lorry is run ahead to the end of the rails, where the men, standing in a row on each side, pass forward the necessary number of ties for a rail length, laying them evenly and properly spaced on the grade, being guided by a line stretched along the grade and a pole properly spaced; a large tie should always be selected for the joint. Next, on each side, the forward gang grasp the end of a rail and pull it forward, and, as the rear end drops from the lorry, it is caught by the rear gang and placed at the end of the rail in the track; then the forward end is dropped to line; this is done on each side simultaneously; the lorry is then run ahead to the end of the two rails just laid and the process repeated. While this work has been going on another lorry load of iron and ties has been loaded and brought forward, the empty lorry tipped on its edge off the track to allow the other to pass, which in its turn is unloaded and sent to the rear for another load. For laying light rails three men at front and two at rear on each side is force enough; for heavy iron more are necessary. As the iron and ties have been run out from the lorry a pair of straps, with the necessary bolts, has been left at each joint, and two spikes dropped at each end of each tie.

Immediately in the rear of the lorry come the *strappers*, who quickly place the fish-plate, or whatever joint fastening may be used, on the joints, and bolt them to place, leaving the proper expansion at each joint; then come the *spikers*, working two together, the two on the line side ahead, spiking usually the joints, quarters, and centres. Before the train is run upon the track each rail is spiked to the tie exactly to a line which a boy has previously chalked on it a certain distance from the end, measured by a short stick, so that when the rail is full spiked and lined, the line end of the ties are in a true and even line. The rail joints should be kept exactly opposite each other, except on curves, when joints should be opposite centres on narrow-gauge track, as it thus retains its alignment much better. Two spikers are also at work on the other side, using a gauge and quickly spiking the rail to place; each set of two spikers have with them a *nipper* or a man with a light iron bar and a block of wood, whose duty it is to hold the tie to the rail while being spiked. Spikes should be driven squarely into the ties so as to have a firm bearing against the rail, both on the side and head of the spike, and should be driven, not in the centre of the tie or exactly opposite on the sides of the rail, but one a little ahead of the other, but both inside spikes should be driven alike, *i. e.*, either ahead or back of the centre of the tie, as it prevents the tie from *rocking*, which it will do if spiked otherwise. As soon as the track is laid and spiked at the joints, quarters, and centres, the train may be run up and kept closely following the workmen. Behind

the train come the back-spikers who complete the spiking, and then the *liners* who throw the track into line, when it is ready for the ballast train. Track-laying is often partially done by machinery by means of adjustable rollers, fastened to the sides of the car, on which the iron and ties are carried to the front along the side of the train; also by a lorry-car running on a track on the supply train. Each method has its advantages, especially where men are scarce.

Ballasting.—As soon as the track is laid the engineer should run his ballast grades, which should be marked by good stout stakes set at the side of the grade, at the foot of the slope of the ballast, opposite the centre stakes, and driven so that the top of the stakes should be as high as the top of the rail at final grade; stakes 200 feet apart on tangents and 50 feet on curves, the same as centres, will answer. The ballast train should consist of as many flats as can be conveniently used and handled, varying with the condition of the pit for loading, the capacity of the engine for hauling, and the force used to do the work. The most economical method, when a convenient pit of material is reached, is to lay a temporary track (or, what is better if it can be done, two tracks into it, by which much time will be saved in shifting trains), then load one train while the other is on the road. Unloading is most economically done under ordinary circumstances by means of a plow worked by a wire cable from the engine; then no time is lost by men in riding back and forth between pit and unloading point, as the train force is sufficient to handle the plow, and the pit force can be adjusted so as to load while the train is making a trip. An estimate of the quantity of ballast to be used should be made so that the trainmen may make a proper distribution of it. Allowing the surface to be uniform at sub grade, the quantity of ballast to raise the track to final grade can be determined very closely and distributed accordingly, so that, when the surfacing is complete, very little or no ballast will remain unused.

In raising track it should first be lifted to final grade at each grade stake and securely packed; then, by use of sighting boards, the joints and centres between the two points are raised to the same grade, except on the vertical curve before alluded to when the intermediate points should be rounded to agree with the curve. On horizontal curves the outside rail should be raised; on 3-foot gauge we raise the outer rail ¾-inch for each degree of curvature up to 5°. All points of the track having been raised to the proper height, and the ballast shoveled in and well tamped the entire length of each tie, the track is ready for lining. A liner and three or more men with lining bars throw the track carefully to the exact centre as indicated by the tack head in the stake driven before track laying; then all parts of the track are thrown to correspond and the rail brought to a true line. One side (it is not essential which) should be taken as the line side, and all lining of ties, iron, or track be done on that side. Following the liners come the finishers, who properly distribute what material may be left by the surfacing gang and give the required surface to the ballast, dress it up neatly, remove any ballast from the

ditches in cuts, and gather up in shape for removing any surplus material. Different companies have different forms of ballasting and dressing. Some raise the ballast nearly as high as the top of the rail in the centre and slope it to the lower edge of the tie at the end; others keep it nearly level with the top of the tie in the centre and nearly as high at end of the tie, and others still have other forms; but on narrow-gauge track it is essential that plenty of ballast should be at and against the ends of the ties, otherwise it will be very difficult to hold the track in line.

Very many points of work have not been alluded to at all, others but slightly, although they all have an important bearing upon the work. We have not mentioned at all what is important, especially to the contractor, monthly and final estimates, also the manner of making them, building of bridges, crossings, etc., and the thousand and one other matters that enter into the work of construction.

Equipment.—But let us consider our road-bed and track as completed, ready for the running of regular trains, and mention some of the necessary equipment for doing business. Of first note is the rolling stock, consisting of locomotives, passenger coaches, baggage, and express cars, box cars, flat and stock cars. The locomotives should, of course, be adapted to the service for which they are intended; those for the passenger service should have a larger wheel and quicker motion than those for freight; so of the other rolling stock, it should be adapted to the class of business required; but I leave the subject of rolling stock for some one better acquainted with it than I am, and mention briefly some of the equipment which more directly concerns the engineer, such as water stations, passenger and freight buildings, shops, engine houses, turntables, etc.

About the first essential is the water supply for engines. During construction work, the engines may be supplied with water pumped by hand directly into the tender tank, or better still by a small steam pump, which may be shifted from point to point, or yet again by a steam syphon and hose carried with the engine, the hose of which can be dropped into any convenient ditch or pond of water by the roadside; in case of emergency, water may be bailed up with pails. All these processes are slow and tedious, and will not do for permanent use. Locations should be chosen at convenient points, at stations or regular stopping places, not exceeding 20 miles apart—15 is better—and tanks of sufficient capacity put up. Tanks of from 20,000 to 30,000 gallons capacity will answer where traffic is not very heavy, or even less would do, but small tanks are not advisable, as the supply is not as lasting, and in severe weather is more liable to freeze. The tanks should be erected upon a frame-work of posts of convenient height, so that the drop pipe will have a good sharp incline when water is being taken. For a tank of 20,000 gallons 12 posts 8″×8″ in size are sufficient; the foundation may be of stone or of piles capped with 8″×8″ for sills, the posts framed into them, and capped at right angles to the sills with 8″×8″ caps, on them rest the floor joists, and on the joists directly the bottom of the tank, the joists being cut away for the chime of the staves; a

tank holding from 20,000 to 30,000 gallons, should be made of 3-inch staves and bottom. To make the tanks frost proof, all that is necessary is to put in a ceiling 18 inches below the top of the staves, and pack it with 18 inches of good sawdust, leaving the space between the top of the staves and roof, which should be perfectly tight, as a dead air space; also to pack it well around the supply, waste, and delivery pipes and under the floor; in extreme cold weather it will of course freeze a little, but not enough to do any damage. There are many different methods of supplying the tanks with water; that most in use is by a small steam pump; wind power is also quite extensively used and is considered quite economical, although my experience has been that it lacks in that respect and is not altogether reliable. Hot air engines are also somewhat used, and I believe are considered economical and reliable. Our company have had one in use at Vassar for the last six or eight months, and are well pleased with its performance thus far. Two much care cannot be taken to have good water and a supply that is permanent. Soft water from streams is considered the best; water containing minerals, especially lime and other substances that coat boilers, should be avoided.

Station buildings come next in importance to water stations, if indeed any gradation in importance can be made; for successful and economical operating all are required. It may be supposed that, during the process of construction, the location has been chosen and the grounds secured. Usually, during the first excitement of the enterprise and the rivalry of the different centres or villages in their effort to secure the road, a choice of location can usually be had, which should be made with reference to the convenience of access, and economy and convenience of laying out the sidings and arranging for the business of the company. It is well to secure ample room at first, for, after the grounds are once secured, it is strange how soon contiguous property appreciates in value, and often it is impossible to obtain more room without buying at exorbitant prices. The station building should be of sufficient size to accommodate the business of the place. In small places, where one man does all the work, I think it advisable to unite the passenger and freight buildings in one, as it is more economical as well as convenient. For places of only a hundred or two of population, where business interests are not very great, I have found a building 16 × 40 feet in size to be ample.

A convenient one is built as follows: 16 × 40, with 12 foot walls, the interior divided in the middle by an ordinary studded partition, making the freight room 16 × 20, and 16 × 20 for a waiting room and office; the office is made by running a lattice partition across from floor to ceiling, 6 feet from the end of the room. This lattice partition allows the waiting-room stove to do duty for the office as well, —another item of economy, as you will please bear in mind that I am speaking especially of the equipment of a narrow gauge road, where cheapness and economy are a desideratum. In front of the office is a bay window, so that the agent or operator has full view of the track each way. In front of the building the platform should be not less than 12 feet wide; we build it 1 foot above the rail with a raised portion 8

feet wide in front of the freight room, and raise the freight room floor above the waiting room floor so as to be on a level with the floor of a box car; the platform across the end and rear of freight room is level with its floor and descends again to the level of the waiting room by an easy incline. For a place of several hundred inhabitants, we build a station 20 × 70 feet in size, similar to the former with the addition of a baggage room; and in large places make them 20 × 100 feet or more. Where two waiting rooms are needed we build the office partially between the two, so as to give convenient access to both. We have found the system of passengers and freight in the same building to work satisfactorily, having in no case, except at terminal stations, any other arrangement, although in very large places it would not be desirable. During construction the engines are usually left standing out of doors with no cover whatever; sometimes a rough temporary shed or engine house is built; but it now becomes necessary to have permanent buildings for them. Such are usually built in a partially circular form, with stalls or divisions to accommodate one engine each. A suitable location is chosen, and a turntable put up, and, radiating from it as a center, the tracks enter each division of the engine-house; underneath each track, inside the house, is built a pit for convenience in working at the underside of the machinery. These houses are usually built of either brick or stone, although cheapness of construction being often demanded, wooden ones may be built with simply a frame work of 8″ × 8″ posts, with 8″ × 8″ caps, 2″ × 6″ studding, 2″ × 10″ and 12″ joists; they should be sheeted around the outside, then papered with heavy building paper, then boarded and battened. Double doors in front of each division may be built on a light frame of 2″ × 4″ in the same way; a tar and gravel roof will do as well as any. At terminal stations and points where engines are kept for yard or other service a small building of sufficient size for the required service should be built, and may be located over an ordinary spur track in a convenient place. At headquarters, in connection with the engine or round-house (as it is usually called from its partially circular form), should be the repair and machine shops, the size, equipment, and capacity of which will depend on the number of engines to be kept in repair, and the amount of work to be done; the more complete they can be made as to machinery and appliances the more economically can the work be done, although of course due regard must be had to the means to do with. It is also necessary to have car repair shops and a place for storage of coaches when not in use. A supply depot is almost a necessity on a road of any importance. It is also necessary that a road should be furnished with the necessary sidings at different points along its line, and yards at terminal and important points for the storage of cars, etc.

Cost.—I am aware that I am already making this article too long and am only touching upon a point here and there, so perhaps I had better close by giving an estimate of the various items of cost that are applicable to a narrow gauge road, as very little of what I have already said will not apply to any gauge of railroad. First the right of way must be secured, which

through a farming and timbered country, like the lower peninsula of Michigan for example, will cost from $20 to $50 per acre, although usually from one-half to three-quarters can be secured as a donation. However, we will say an average of $40 per acre, which gives, for a right of way 4 rods wide, 8 acres or $320 per mile. Clearing through the average country above alluded to can be done for $25 per acre, or $200 per mile, and grubbing will average perhaps $100 per mile, though in heavy timbered land it will cost very much more. A fair price for ordinary earthwork is 25 cents per yard, and at 5000 yards per mile, (although on the P. H. & N. W. Ry., of over 200 miles, the average has been less than 4000 yards per mile), we shall have for earthwork $1,250. Bridges, if not too expensive, may be figured $200 per mile and culverts at $100. This will give for right of way and road bed as follows:

Right of way	$320
Clearing	200
Grubbing	100
Earthwork	1250
Bridges and culverts	300
Total	$2170

Ties will cost say 20 cents, although the average price paid for more than half a million ties used by the P. H. & N. W. Ry., has been but little more than 10 cents.

2,640 ties per mile at 20¢	$528.00
Rails, (steel) 35 lbs. per yard, 55 tons per mile, at $50 per ton	2750.00
Fish plates, 532 pairs, weighing 8 lbs. per pair, at 3¢ lb.	127.08
1,408 bolts, ½ lb. each, at 4¢	28.16
Spikes, 27 kegs per mile, 150 lbs. per keg, at 3¢ lb. (now considerably less)	121.50
Track laying per mile	200.00
Ballasting, 350 yd. 1,100 yds. per mile	385.00
Making per mile	$4139.74
To which we must add about 5% minimum for siding, etc	206.98
Total per mile	$4346.72

We will perhaps arrive at a better result for equipment by considering the amount needed for 100 miles of road. Let us say,

8 locomotives, from 14 to 20 tons @ $8000 each	$64,000
6 first-class coaches @ $3000 each	18,000
6 second-class coaches @ $2300 each	13,800
4 baggage and express cars, @$1700 each	6,800
150 box cars @ $325	48,750
10 stock cars @ $350	3,500
50 flat cars @ $225	11,250
Hand-cars	900
Total for rolling stock	$167,000

or $1,670 per mile.

Water stations at terminal stations, and 4 intermediate on the 100 miles will cost $700 each	$4,200
For station buildings we will say 12,—6 of the smaller size mentioned, which with platform and outbuildings complete will cost $600 each	$3,600
Four, 20′ × 70′ in size @ $1,000 each	4,000
Two, 20′ × 100′ in size @ $1,300	2,600
Larger passenger and freight buildings at headquarters costing	15,000
Engine-house of eight stalls at headquarters	2,000
Small engine-house at other end of line	500
Two turn-tables @ $600 each	1,200
Machine shops and machinery	10,000
Car repair shops	6,000
Coach house	1,000
Telegraph line	5,000
Total	$55,100

or $551 per mile. Making a summary as follows:

Right of way, road-bed, etc., per mile	$2170.00
Ties, iron, track-laying, ballasting, etc	4346.72
Rolling stock equipment	1670.00
Buildings	551.00
Fencing	600.00
Making a total per mile of	$9337.72

to which may be added engineering and contingent expenses, which will make in round numbers at least $9,500 per mile.

DISCUSSION.

MR. G. M. BROWN: I consider hemlock the best timber for ties, not especially for its durability, but for its property of holding spikes. In laying ties of different kinds of timber, I would place each kind, hardwood and soft, by itself. The ties on the F. & P. M. R. R., are 8 feet long and 8 inches wide; their average cost on our road in 1883 was 18 cents.

MR. W. B. SEARS: The greatest enemy the railroad engineer encounters is the swamp. In this state swamps are frequently found, that, so far as firm ground is concerned, are nearly bottomless. Small ones will absorb acres of timber and thousands upon thousands of yards of earth, and even then the grade that is obtained cannot be held. They are well called "sink-holes." In one instance I have driven piles 160 feet.

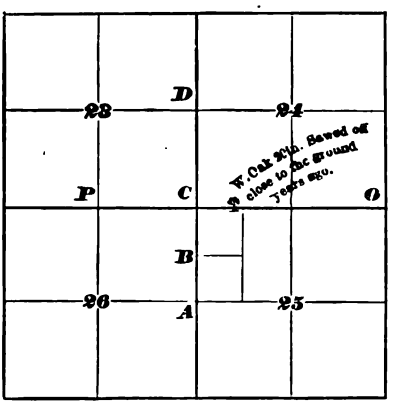
I have had success in putting on a layer of trees before the earth.

M. J. J. WATKINS: In the older part of the state ties cost from 30 to 40 cents each.

MR. A. L. REED: As to making embankments narrow and afterwards widening them, this plan requires more earth and is in danger of slips. Our practice is to build full width before the rails are laid. In regard to ties, I gave figures of actual cost for ties seven feet long, six inches face. I think cedar the more valuable.

QUESTIONS IN PRACTICE.

1. This diagram represents sections 23, 24, 25 and 26, T. 1 N., R. 2 W. (Onondaga, Ingham Co.). The section corner *C* being lost Mr. R. attempted to locate it by running *O P* and measurement from a station tree given in the United States survey as being 60.07 chains from P, and *O C* by the original survey as 79.98 chains. But in the year 1839, 13 years after the survey of the townsip, Mr. J., then county surveyor, was called to subdivide the N. W. ¼ of Section 25, at which time he located the corner *B* and his record shows it to have been placed equidistant between *A* and *C*. As the quarter post *A* is still visible, and the point *B* found by the county records before mentioned, I ran the line from *A*, through *B* to *C*, making *P C* = *A B*, thus corresponding with the record. Then the distance *C D* was measured, and varied but one link from *A C*, which distances were each made a half mile or 40 chains by the original surveyors.



This point has been a bone of contention for a long time, it being the centre of a state road on the east and west line, therefore I would like to have my method of procedure considered by the association.

A. P. DRAKE, Mason, Mich.

Answer—BY I. H. LEAVENWORTH.—The point *B*, having been located equidistant from *A* and *C*, becomes an evidence of the location of the point *C* and should be so considered, especially as the latter is so nearly equidistant from *A* and *D*. (Adopted.)

2. How shall the surveyor proceed in platting villages or cemeteries, especially where timber is standing, in order that his lines shall be correct and his stakes in the right places when the work is finished?

JOHN M. SANBORN, Gaylord, Mich.

Answer—BY I. H. LEAVENWORTH.—By using a good transit and measuring all angles carefully with the verniers of the instrument, independently of the needle, ranging all lines by the telescope, and making the measurements with great care, there is no reason why villages and cemeteries, laid out in the woods, will not prove to be properly surveyed when the land is cleared up and the streets graded. The great trouble with village plats arises from a lack of care in the first survey; they are frequently laid out with compass and chain, running from tree to tree, and bending the chain over logs and around trees, brush or other obstacles, and it is impossible to do good work in that way. (Adopted.)

3. Is it advisable for surveyors at present to adopt the metrical system in town and similar surveys? S. C. HODGMAN, Traverse City.

Answer.—The serious objection to this plan is that all of our surveys are made with either feet or chains and links, and the introduction of a new system would also introduce new complications. (Adopted.)

4. What is the least practicable grade for cobble stone gutters for carrying off storm waters, and what are their advantages?

Answer—BY H. G. ROTHWELL.—I have laid a cobble stone gutter with a grade of 0.20 to 100 feet and it works tolerably well; but I should prefer more. I now aim to get not less than one foot in 350 feet and find that the gutter keeps cleaner and better for it. The specification for cobble stone gutters used by me is:

Gutters.—Are to be paved with cobble stone, set —— feet wide from the curb, and of the form shown on the plan and cross section. The paving stones must be heavy and hard and not less than six (6) inches or more than eight (8) inches in depth. Stones of similar size are to be placed together and so as to break joints with the adjoining stone. The largest stones shall be laid next to the curb, and the smallest towards the centre of the street, and shall measure fourteen (14) inches, sand and stone, when pounded and set.

Pounding and Finishing the Gutters.—All sand and gravel shall be scraped and swept off the surface before being pounded. All pavement when laid shall be thoroughly rammed and pounded, with a pounder not more than ten inches in diameter, at least three times, the first parallel with the street, and twice across the street, in a thorough manner, with a maul weighing not less than seventy-five (75) pounds; the unevenness of surface of the paving shall not be over one inch before it is pounded, and the whole surface of pavement, when finished, shall conform to the true grade and cross-section, as directed by the person or persons designated or appointed by the Common Council to accept the same. All gutters paved with stone shall not be covered with sand or gravel until the same is inspected by the proper person or persons appointed for such pur-

pose, and when inspected and accepted shall be covered with one inch and one-quarter (1¼) of bank sand and gravel.

Ballasting for Cobble Stone Gutters.—A bed of ballasting of bank sand and gravel, not less than six (6) inches in depth, four (4) inches of which shall be placed upon the road bed previously prepared to receive it, and shall be evenly spread and rounded to the shape of the street, and shall be well rolled, at least one block at a time before being paved, with a roller weighing at least 2,400 pounds, and then the balance to be placed over the road bed; making a depth of at least six inches preparatory to paving the gutters.

Whenever sand or gravel is specified, it must be of the best quality, and subject to the acceptance of the person or persons designated or appointed by the Common Council to accept the same; and all material which shall be rejected by him or them shall be immediately removed from the street.

The advantages of cobble stone gutters I find to be very few, more apparent than real. With us they cost more per yard, are more difficult to keep to grade, always getting hollows and depressions where horses stand and stamp with their feet, also where much water is used, as at a private or public hydrant, the water washing out the earthy matter of the bank sand and the gutter settling. They are also more difficult to clean and to keep clean. The class of workmen who lay these gutters are, as a rule, not good ones; the cobble stones in this vicinity are not first-class either in shape or hardness. On the whole I prefer the wooden gutter with drain tile laid underneath it as being cleaner, easier kept clean, presenting a smoother drainage surface, costing less, and lasting just as long as the rest of the pavement.

5. What is the best means of carrying the water of surface drained streets across other streets at their intersections?

Answer—By H. G. Rothwell.—The method adopted here is to bridge over the ditch, which is dug with long slopes at these points, the bridge plank being easily removed for the purpose of cleaning and cheaper with us than any other method. We use it only on earth streets where the sewerage system has not been extended.

6. President Davis wanted the members from Lansing to give their method of constructing deep ditches in quicksand.

Mr. H. D. B. Bartholemew.—I have had some experience, and at first had much difficulty, but succeeded admirably when the sand was not very deep by using a box without top or bottom, made from an old locomotive fire box. This was set in place, driven down, the sand shoveled out, the pipes laid, the box pulled up and moved forward. In one instance I put down a drain with great difficulty, and dried, as we afterward found, all the wells within one-fourth of a mile.

Mr. W. Appleton.—I have made several deep excavations in quicksand. In sinking a well 20 feet deep, I used for a curb white oak sheet piling, but found that such curbing was not safe; the workmen were in constant danger for their life: I would never use it again. I have used a

curbing of horizontal plank, driven down between upright sheet piles with great success, safety and economy. This curbing is put down in sections. In refilling, the lower planks are taken out, firm earth thrown in, and as a result no planks are lost.

PROFESSOR R. C. CARPENTER.—My experience has tallied exactly with that of Mr. Appleton; we tried various systems of curbing with little success until we used horizontal planks or boards between upright posts. This style of curbing can be settled to a great depth with safety. The earth is first thrown out below the horizontal boards on the edge of the ditch; these are at once crowded down to the full depth, and the side boards from above pushed down one at a time, leaving the bottom of the ditch crowning and perhaps one foot higher than the bottom edge of the curb boards. This earth can be safely thrown out to the bottom of the curbing when the process may be repeated. It will be necessary to lower the posts from time to time. If the ditch is very deep it may be necessary to use several sets of posts, leaving an offset where one set ends and another begins. For braces we have succeeded well with pieces of pine 2″ × 4″ or 4″ × 4″. For removing our curbing it is necessary to use braces somewhat longer and set directly against the horizontal planks, in which case the vertical posts can be removed. In removing, the boards are taken in order from the bottom as the filling progresses.

In laying tile in quicksand some protection should be put on at the joints; the best covering is probably a piece of closely shaven turf, as it affords lateral support as well as protection. Neither sewer pipe nor tile need to be laid on boards or other support, as the tendency of the pressure is to raise the pipe rather than to press it down.

MR. M. W. BULLOCK.—I have found when caulking was necessary for quicksand curbing, that wool was the best material to use, marsh hay the second best.

PROFESSOR J. B. DAVIS—Spoke of sinking piles in quicksand by aid of the water jet. The pile is not sharpened, but a notch is cut in the lower end so that a one-inch water pipe may be passed along the side and bent so as to terminate under the pile. The pile is set in position and the water applied with force. The sand will be driven from beneath the pile and it will sink rapidly. The jet of water once started must not be stopped until the pile is in place, for if the water pipe gets filled with hard quicksand it cannot be driven out by the water.

TEMPORARY TIMBER TRESTLE AT GRAND RAPIDS, MICH.

By GEORGE MASSON, Chief Engineer D., G.-H. & M. Ry., Detroit.

The summer of 1883 was remarkable for a succession of freshets which occurred about four weeks apart, during the months of May, June and July. At and near Grand Rapids, on the 21st, 22d and 23d of July, a succession of rain storms occurred, in which the rainfall was much in excess of anything before known at this season of the year, in that section.

Previously the Grand River was at high-water mark from the constant rains. About 700,000 logs were in the river above the dam at Grand Rapids, the van resting on and held back by the piers of the Detroit, Grand Haven & Milwaukee Railway bridge. These logs were secured by booms, ropes and chains fastened to the bridge piers, and extended across the whole width of the river, thereby damming it back to the height of 3 feet at the rear end of the logs. From Monday until Thursday morning the piers sustained this tremendous pressure. The superstructure consisted of five iron plate girders of 100 feet span each, 10 feet deep and 10 feet wide from centre to centre of beams, and two shore end spans 60 feet long. These girders rested upon six cribs, which in turn stood upon six sub-cribs, all filled with cobble stone and securely framed together, having ice-breakers and everything necessary to withstand any ordinary freshet.

When the booms eventually gave way, three of the long girders were canted off the piers and carried down the river, and two of the upper piers swept away. This left a gap of 300 feet which had to be bridged before trains could again cross the river.

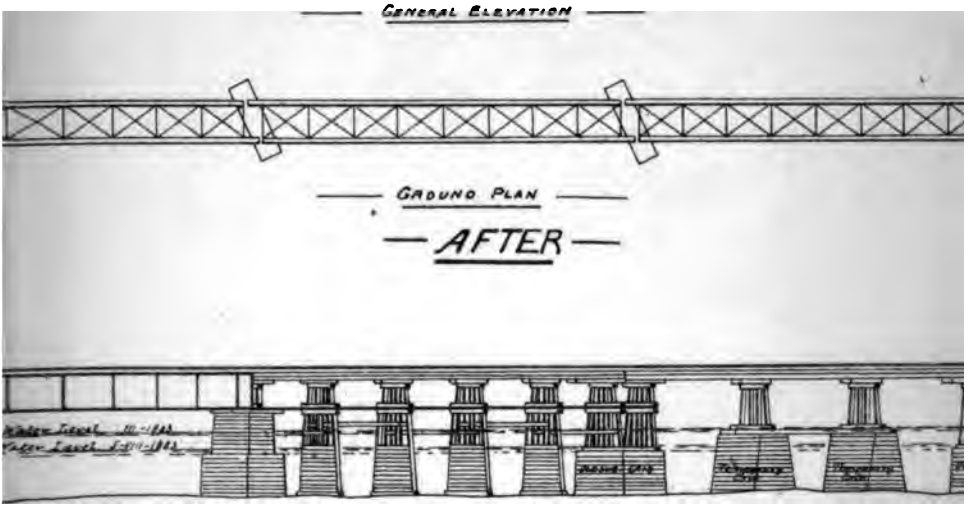
A temporary trestle was determined on as the only way by which traffic could be resumed in a reasonable time. The difficulties encountered, however, were very great. The water was 15 feet deep, the current very strong, many logs were still running, and the bed of the river was rock, covered with boulders. The 100 feet at the east end was bridged with 20-feet spans, double bents and two double stringers 12″×12″, as shown on the accompanying sketch. This construction, however, was found to be very slow in erection, and setting the bents very difficult on account of the boulders.

A different plan was determined on, which consisted in placing two timber cribs between the sub-piers of the old bridge, and erecting thereon single bents, thus making spans of the unusual length of 34 feet. These openings were bridged with four double stringers, each consisting of one piece of 12″×12″, and one of 12″×16″, placed on top of one another.

The temporary timber cribs require special mention. They consisted of four mudsills 12″×12″×40′ placed parallel to each other and about 3 feet

— BEFORE —

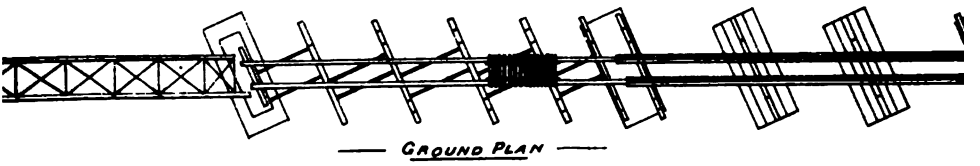
— General Elevation —



— Ground Plan —

— AFTER —

— General Elevation —



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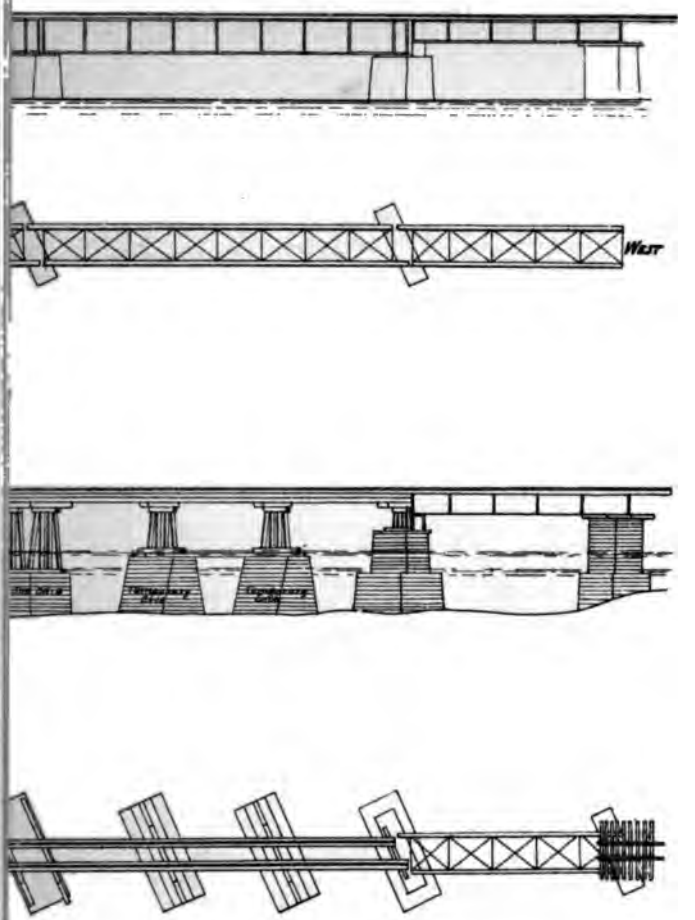

OIT, GRAND HAVEN & MILWAUKEE RAILWAY.

ND RIVER BRIDGE

EFORE AND AFTER LOG JAM, JULY, 1883.

RRANGEMENTS FOR TEMPORARY USE AND RECONSTRUCTION.

Y PAPER READ AT THE ANNUAL CONVENTION OF MICHIGAN
F SURVEYORS AND CIVIL ENGINEERS, LANSING, MICH., JAN-
4. BY GEORGE MASSON, CHIEF ENGINEER DETROIT, GRAND
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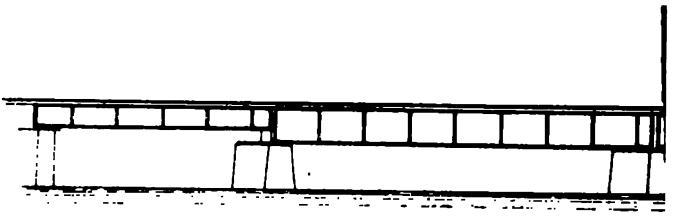

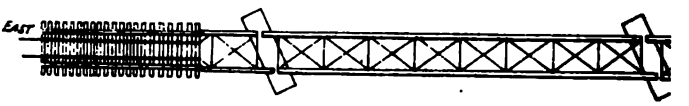
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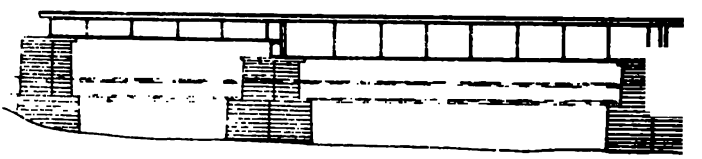

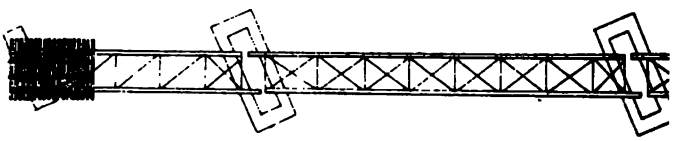

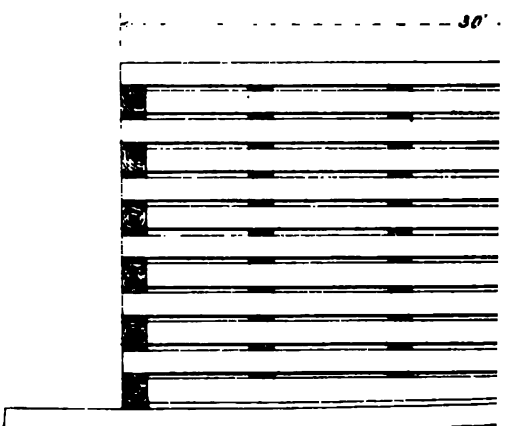
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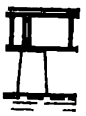

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apart. On the top of these was spiked a 3″ plank deck which formed the bottom of the crib. On the top of this again was placed the first course of timber of the crib, consisting of two end pieces 12 feet long, and two longitudinal pieces 28 feet long, the ends of the latter butting up to the sides of the former; these four pieces were securely bolted through to the mudsills. On top of this course was spiked a number of cross-ties of 3″ plank placed about 6 feet apart; and then a second course, consisting of two end pieces 9′ 6″ long, and two longitudinal pieces 30 feet long, the ends of the former butting up to the sides of the latter, thus breaking joint with the course below, was drift-bolted to the lower course and the ties. This second course was the same length as the first but 6 inches narrower. Each succeeding course was made 6 inches narrower than, and to break joint with the one below, and in this manner were built up to the required height and then filled with cobble stone. The whole structure was put together with the intention of saving the timber as much as possible, that it might be available for subsequent use. Attached is a sketch showing the manner of construction. This latter plan worked admirably and may prove of use in similar cases hereafter.

The first bent was raised on the 30th of July. On the 10th of August traffic was again resumed.

PUBLIC WATER SUPPLY AND WATER WORKS.

By W. R. COATS, of Kalamazoo, Mich.

My subject, "Public Water Supply and Water Works," if not a subject of paramount general interest, certainly is a question second to not other in its interest and importance to the engineer, and in its relation to the health and prosperity of all communities. Up to the present time this great question has never received the attention its importance merits either from the engineer or from the general public. While we have made great strides in advance in very much that pertains to this field of work, yet in other directions, we are not at all in advance of the ancients.

It has been suggested that if I should confine my paper to a description of the Kalamazoo water supply and water works, it would be sufficient. But this would be too personal to myself to be agreeable, and I think would not prove as interesting and instructive as a paper commanding a wider range. There is very much about the Kalamazoo water supply that is peculiarly interesting, and a complete knowledge of which will prove exceedingly valuable to this Society and to the engineering world generally; I shall endeavor in the proper place to give a brief and concise description of it.

The close student of history will be compelled to admit that relatively more attention and care was bestowed upon this great question in ancient times than is given to it to-day. The great improvements made during the last 20 years in all the mechanical appliances involved in this great field of work leave little to be desired in this direction; but in other respects we are far behind the requirements of the age. We all regard with deep interest the great hydraulic works of the old Romans, but if we explore the solitudes of Africa, we discover evidences of still greater works gone into decay and ruin, long before the Roman Empire had an existence.

The historian Gibbon, in his history of the "Decline and Fall of the Roman Empire," says, concerning these great works: "The boldness of the enterprise, the solidity of the execution, and the uses to which they were subservient, rank the aqueducts among the noblest monuments of Roman genius and power." "The aqueducts of the capital claim just preeminence, but the curious traveler, who, without the light of history, should examine those of Spoletto, of Metz, or of Segovia, would very naturally conclude that those provincial towns were once the residence of some potent monarch."

While it is true that gravity works, pure and simple, are the most efficient and excellent, as nature is in all things superior to art, yet the great obstacles to be overcome in most cases render the construction of such works impracticable. The great hydraulic works of the ancients will ever

remain objects worthy the highest praise and commendation of the modern engineer; and while our modern appliances for handling and controlling water are such that we do not need to emulate their prodigous efforts, yet we should be able to draw inspiration from the study of the work of our great predecessors, to help and strengthen us in all the difficult and arduous work of our profession to-day.

In many of the great essentials the engineer of the olden time has never been surpassed, possibly never will be. In that greatest of all essentials in the development of water supplies, *source*, it is probably true that we are less careful, less painstaking to-day than was our great brother of 2,000 years ago. We make less effort to secure a pure source of supply, to avoid polluted streams and stagnant ponds than did they.

The water supply, both public and private, of four-fifths of our cities and villages is of such a character that we simply neglect the plainest duties in not taking radical steps for improvement. The public health and prosperity is impaired by this condition of things to an extent little dreamed of by the people generally.

Heretofore nearly all of our prominent engineers have seemed wedded to the belief that none but surface supplies, streams, lakes, impounding reservoirs, etc., were to be depended upon for adequate supplies. A few have advocated the opposite extreme—artesian sources. Usually we find when two extremes are advocated, that the true course lies midway between, and nowhere in my judgment can a more striking confirmation of this principle be found than in the subject before us.

From the very nature of the case, simple surface supplies are always impure. The surface wash of every section of country is largely contaminated with vegetable and other organic matter, and is seldom in any sense fit for domestic use. The deep-seated waters obtained from artesian sources are also unfit for use, because of the large amount of mineral matter which they usually carry. The casual observer will naturally conclude that if all surface waters are bad, and the deep-seated waters are also bad, we must look to our ordinary wells for good water. Here again he is at fault, and more seriously so than in either of the other cases.

Nowhere lurks so much danger in the water we drink as in our fancied pure well supplies. The old poetic song and pleasant fiction: "the old oaken bucket which hung in the well," covers a mass of corruption which I fancy the poet was as ignorant of as the child unborn.

For drinking and culinary purposes the water of our ordinary wells should never be used; such waters are almost invariably contaminated to a much greater extent than simple surface supplies. There is a much more active drainage movement going on beneath the surface, and hence out of our sight, than most persons dream of. The drainage from the surface, filth from our privy vaults and cess-pool abominations finds its way readily into and corrupts the water stratum that feeds our wells, to an extent that would appall, were it generally known and appreciated. Most people think that so long as the water from their wells is clear and sparkling and is not offensive to the taste, it is of necessity pure and safe. No contaminations are so dangerous in our drinking water as those coming from

the drainage of privy vaults and cess-pools, and no contaminations are so difficult to detect without the aid of chemical analysis. Chlorine may be present in our well waters in highly dangerous quantity, and we be entirely unable to detect its presence by looks, taste or smell.

It will then be asked, where are we to look for pure water, if our wells and all surface supplies are impure? The question is easily answered. The surface waters and the deep-seated artesian waters, and the waters of our ordinary wells are bad from the causes before named; but if we examine a little further we will find a source of supply free from all the above-named contaminations, and perfectly fitted in every respect to our best use. It is found that the upper levels of all subterranean water strata are contaminated by the drainage of all the filth of the vicinity, but if we study and analyze carefully, we find that these contaminations do not penetrate to any great depth into the waters of the strata, no matter how porous the strata may be, but are arrested and held in suspension near the upper levels of the stratum. If the waters of these strata do not become contaminated to any great depth, all that is necessary to avoid the polluted water and to obtain that which is good is to sink our wells in such a manner as to exclude the bad water and admit the good, and this is very simple; if instead of constructing our wells in the usual way, only penetrating the water stratum just sufficiently to obtain the amount of water we require and admitting the water at all levels, we carry them down 10, 15, or 20 feet into the water stratum, admitting water only from the bottom (thus shutting out the contaminated waters of the upper levels) the question is solved, all the difficulties are removed, and we have secured a perfect water supply.

My first discovery of this remarkable and important fact (that organic contaminations do not sink deeply into a water stratum), was at the time of my investigations and experiments leading to the discovery and development of the Kalamazoo water supply in 1871.

Two years previous to this time the village had begun the construction of a system of water works. In the outset it was only contemplated that the works should furnish a supply for fire service, and the question of the quality of the water was not considered. The supply was taken from a brook running through the place. It was soon found, however, that a public water supply was such a great luxury and convenience that a popular demand arose for a general service. The brook not furnishing a fit supply for domestic use, it was necessary to seek such supply from some other source. After careful investigation, I became satisfied that an adequate supply could be obtained, by sinking a well of large size to a proper depth into the water bearing stratum of sand and gravel, which underlies the locality.

My sole object, at this time, in sinking the well deeper into the water stratum was to secure a greater yield of water under the head that could thus be brought to bear by reducing the water in the well below its normal level. In this manner I calculated that we should be able to command all the water that could be forced through the strata, under the influence of whatever head we should be able to bring to bear, provided always the

tributary water-shed at our command was sufficient to furnish it. The result in this case, and indeed in all my subsequent experience, has completely verified these calculations.

Up to this stage of the investigations, it had been taken for granted that the quality of water from such a well would be good; but, upon subjecting the waters of the private wells of the vicinity to a careful chemical analysis, they were found more dangerously contaminated than the waters of the streams. Here then was another dilemma. If the waters of the small private well sunk in this same stratum furnished impure water, what better could be expected from our contemplated large public well. I therefore had samples of water analyzed that were taken from the experimental tubes sunk to test the strata conditions at the locality of the proposed public well. At the surface of the water stratum the conditions were found to be the same as in the private wells; the water was bad, but I discovered this remarkable fact: while the water of the upper level of of this stratum was badly contaminated, a few feet below it was pure and good. Upon fully investigating this strange feature of the case, I became thoroughly convinced that it was a fixed natural principle, that all organic matter which finds its way to the waters of a subterranean stratum is arrested and held near the surface of such stratum, and the water of the stratum therefore does not become contaminated to any great depth. All the subsequent years of experience have fully sustained this conviction.

The public well at Kalamazoo has furnished the entire village with water for nearly twelve years, and has been tested to the extent of 4,000,000 gallons daily, and the water is entirely free from all organic matter; while the waters of the private wells of the vicinity, deriving their waters from the same stratum, contain large quantities of organic matter, and are a standing menace to the health of all who use them. The greater purity of the water of the public well is entirely owing to the peculiar manner of its construction.

In the case of the public well a caisson with impervious sides is sunk to the depth of 26 feet into this water stratum, admitting the water only at the bottom, and thus taking its supply far below the reach of all surface contaminations. The private wells, only slightly penetrating this water stratum, are subject to all the contaminations that reach the stratum.

All questions as the quality of the contemplated supply being now satisfactorily settled, I was authorized by the village board to consult with some of the leading hydraulic engineers of the country and ascertain their views as to the feasibility of my plans. My first visit was to one of the most celebrated engineers of that time, and I met with such an experience as to discourage further inquiry in that direction. This engineer unhesitatingly condemned all my plans, and ridiculed the idea of obtaining a water supply in the manner proposed. "Impossible," he says, "ridiculous, to think of obtaining an adequate supply of water for a town of 10,000 inhabitants from a well."

This engineer belonged to the old school, and had no faith in any other than surface supplies. I returned home but did not report the result of my conference to the board. I found that if I faithfully reported

I would not be permitted to go on with the enterprise; I was still convinced, however, that I was right, and despite the fact that my project was ridiculed by the majority, I still retained the "courage of my convictions," and urged the enterprise in every way, until finally a majority of the village board accepted and adopted my plans, and authorized me to go on with the work; the result far exceeded even my own expectations.

Considered from a sanitary point of view the Kalamazoo water supply is beyond question the finest in this country; and a twelve years' trial has fully demonstrated the adequacy and permanence of the source of supply. It certainly seems little less than wonderful (to all those unacquainted with the underlying principles), that a well twenty-four feet in diameter can be depended upon for a daily supply of 4,000,000 gallons of water, but such is the simple fact, and there are no features of the case, or principles involved which may not be readily comprehended by the engineer who will view the matter from a correct standpoint; indeed everything is very simple and plain, and the marvel is that the situation has not been mastered long before.

The Kalamazoo case is not an exceptional one, or perhaps, more correctly, the natural conditions existing at Kalamazoo are not exceptional. I find in my investigations in various cities, in all parts of the country, that in the majority of cases, the conditions are as favorable as at Kalamazoo. Given adequate watershed with favorable strata conditions—success (with a proper effort) is assured. A competent engineer can determine by a proper investigation in any case, the feasibility of a water supply from subterranean sources, almost as easily and surely as he can determine the questions involved in surface sources of supply.

I will give a brief description of the mode of development of the Kalamazoo supply: The plan contemplated the construction of a circular caisson 24 feet in diameter and composed of iron, brick and hydraulic cement. with impervious sides, to be sunk to the depth of 26 feet into the water bearing stratum. To accomplish this work I first made a circular excavation thirty feet in diameter down to the water bearing stratum (temporarily sheeting the sides to prevent caving). At the water level a heavy iron shoe cast in eight segments was placed, forming when joined together a complete circle 24 feet in diameter, the base of the shoe terminating in a cutting edge. Secured to this shoe and extending to the height of 26 feet a complete skeleton frame-work of iron was provided, giving a complete vertical and horizontal bond to the entire structure. A brick wall 26 inches thick at the base and 18 inches in thickness at the top, the batter being upon the outside to lessen friction in sinking, was then constructed upon the shoe; the wall was laid in cement mortar, thoroughly grouted, and when finished was nicely plastered with two coats of cement inside and outside. This caisson was built complete before sinking. The reason for building a caisson of such strength was to secure it against damage from the great strains which would be brought to bear upon it during the process of sinking to its permanent place.

Everything was now ready for the critical part of the work, nearly all holding to the belief that the caisson could not be carried down to place,

without removing the water as the work progressed. From the first I had determined to perform the work without resorting to pumping; the great objection to the removal of the water being the great disturbance of the strata conditions, which would result from the violence of the inflowing waters, tending to displace and carry into the caisson large quantities of sand and gravel of the water bearing stratum, which in turn would be replaced by the silt and soil from above, thus obstructing the natural flow of water into the well after its completion. To reach the depth contemplated it was believed at the time that two or three times the amount of water required to supply the village would be encountered. The result demonstrated that it would have been necessary to dispose of 8,000,000 gallons of water daily, had the attempt been made to keep the caisson free from water while sinking. No difficulty was encountered in sinking the caisson to place, without the slightest damage to the structure.

The depth to which it was necessary to carry the caisson into the water bearing stratum in order to secure an adequate supply without reducing the normal level of water in the well too low to have an ample protecting shield at all times, above the base of the caisson, to ensure the purity of the water of the well by shutting out the contaminated water of the upper levels, made it absolutely essential that the maximum capacity of the well should be greatly in excess of the maximum demand of the works, and that all the demands of the works should be met before reducing the level of the water in the well beyond one-half of its entire depth. A test of 4,000,000 gallons per day reduces the level of water in this well but a trifle more than one-third its depth, when the violence of the inflow results in turbid water, thus showing the limit of this stratum to furnish water in fit condition for use, through an opening of this size. At the same time it is no measure of the capacity of the stratum to furnish water. The case in question is a most complete, exhaustive and successful demonstration of the question of subterranean water supply, and has resulted in the development of resources before undreamed of by the most sanguine engineer.

The source of supply being settled, and this should always be the first question to settle, when water works are contemplated, we should look for the best and most efficient system of works, by which to distribute this supply to those requiring it. As stated in the outset, gravity works pure and simple are superior to all others in efficiency and reliableness of service, and in economy of management and maintenance, but in the great majority of cases the natural conditions will not permit the construction of this class of works. We therefore are obliged to resort to pumping in the distribution of our water supply; but even then we should always make use of as much of the gravity principle as is possible, and it is always possible to combine the gravity service with our pumping service advantageously; while often expensive, in all cases the added efficiency and the saving in the cost of maintenance of such works, will more than repay the greater first cost, as compared with direct pumping works.

Much has been claimed of late years for what is called the direct and variable pressure system, but some of these points are misleading. While it is true that the great improvements in all the mechanical appliances for

handling water are such as to leave little to be desired in this direction, yet Nature still asserts her claims, and maintains her position as the most reliable and perfect in all her work. Our excellent pumping machinery of the present time renders it possible for all communities, great or small, to provide a proper public water supply. The pump manufacturers of our country can with equal facility meet the demands for machinery to supply 100,000 or 100,000,000 gallons of water daily, so that the provision of a proper public water supply is only dependent upon the intelligence, public spirit, and enterprise of the community.

Many communities are frightened by the necessarily large expense involved in the construction of a good system of works, while many others rush in blindly under the guidance of incompetent counsel, or no counsel at all, allow their zeal to run away with their discretion, and in the end find that their works are far from being first-class in any respect, while perhaps they have cost far more than a proper price for good works. Our own state has suffered very severely under this class of engineering, or lack of engineering. Unfortunate as is this class of cases yet it is rare that even a poor water works is not worth more than its cost, as compared with no works at all; but we are now arrived at a stage of experience and intelligence which leaves no excuse for further mistakes in this direction. The average community have access to sources of information that will afford ample protection against quackery of all kinds, and it is only the blind and the vicious who will not see.

Nearly all the water works of our State are of the pattern known as direct pressure works, that is the water is delivered through the mains from the pumps, direct to the consumer without the intervention of stand-pipe, tower, or reservoir. It is claimed for such works by their advocates that the "direct system" obviates the necessity for expensive reservoirs and permits of the delivery of water at variable pressures, thus adapting the works of this class to various services, such as domestic, fire service, etc.

While I fully believe in a fire service directly from the mains, thus obviating the necessity for, and saving the great expense of a steamer service, and at the same time securing greater efficiency and reliability, yet the best way to secure this result is not found in a dependence upon a service entirely and directly from the pumps. The best of machinery is liable to give out, and the chances of failure in the service in question are vastly greater at just the time when failure will result in the greatest disaster, to wit, during the prevalence of a fire, when everything is strained to its utmost tension; also such a dependence requires pumping machinery of at least quadruple the capacity required for ordinary service and to furnish efficient work must, at great expense, be kept always in readiness for extra duty.

The claim of superior merit for a system of works on the plan of "variable pressure," that is one pressure in the mains for ordinary service, and another and much higher for fire service, is a complete fallacy. The Kalamazoo works clearly demonstrate this. In this case the pressure carried at pumping station for ordinary work is 45 pounds. For fire service the pressure is doubled. In all cases, and it is the same here, fully 75 per

cent. of the water pumped is wasted through openings constantly running, such as urinals, water-closets, lawn sprinklers, fountains, etc. We will say that these openings are all gauged to deliver a given quantity of water under the normal pressure of 45 pounds, and the amount being discharged is at the rate of 1,000,000 gallons per day. A fire breaks out, and the pressure is raised to 90 pounds in order to furnish the needed force with which to fight the fire; no one thinks of the thousand little wastes that under the ordinary conditions were wasting 1,000,000 gallons of water and are now disposing of 2,000,000, because of the increased pressure, thus greatly reducing, at this most critical time, our power to successfully cope with the fire. This objection would not prevail had our pressure been constant at 90 pounds all the time, as then all these wastes would have been gauged for this degree of pressure.

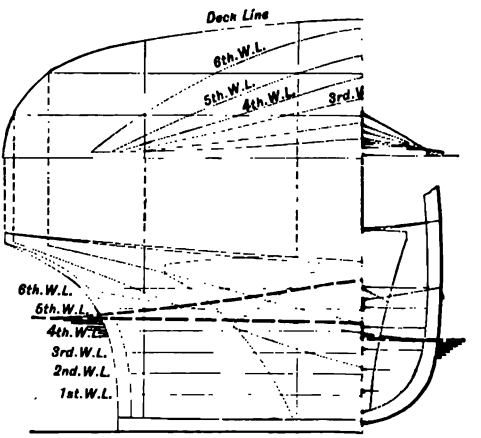
In all cases where the gravity system, pure and simple, cannot be established, I am clearly of opinion that the reservoir and pumping system combined furnish the best results. In no case would I advocate a stand-pipe, as, having no storage capacity of consequence, the limited office performed by it affords but very slight return for its cost; nor would I advocate open earth reservoirs, exposed to all manner of filth and great variations of temperature.

I have made plans for five different works this season, in which I adopt the pumping and reservoir service combined. In each of these cases my reservoir is a steel tank, of a capacity of one full day's supply for the demands of the place for which it is built. This reservoir is placed upon a foundation of masonry (if there are any natural elevations available of sufficient height to furnish the desired service); if not, then a trestled tower of sufficient height is constructed, and the reservoir placed upon it, and the whole enclosed with a circular wall of masonry roofed over, effectually protecting the water in the reservoir against all objectionable influences.

With such works it is only contemplated running the pumping machinery during the day, allowing the reservoir to perform the night service. The pumps during the day are run to a capacity sufficiently in excess of the ordinary demands to fill the reservoir. Thus we gain at all times a service from our reservoir for both ordinary service and fire service, equal to the full capacity of our mains to deliver the water; besides, if our reservoir and pumps are properly placed with reference to their relative work, both will work harmoniously together to supply any extraordinary demand made upon them, thus giving us the benefit of the full power of each, so long as the emergency shall last. This plan enables us to run the pumps regularly up to their healthy capacity, thus securing economical work, which is impossible under the variable and direct service plan, and it also enables us to dispense with one set of men and all night work. In each of the above five cases I estimate that I shall secure a saving of expense in the operation of the works which, capitalized, will more than offset the enhanced cost of these works over simple direct pumping works.

The comparative efficiency of these two classes of works may be seen by contrasting the little works of Petoskey, with those of Kalamazoo. In

1880 I planned a water works for Petoskey. I only provided them with a pumping capacity of half a million gallons per day; but as an auxiliary for fire service I placed in an elevated position an iron tank or reservoir. These works, complete, cost less than $20,000; yet they will furnish a fire service fully three times greater than the Kalamazoo works can furnish, while the latter works cost ten times more than the former. Notwithstanding the great disparity in the efficiency of these works, Kalamazoo possesses natural advantages of a very superior character, which, if properly developed, would at once place her water works in the first rank for efficiency and excellence of service, thus placing her first in all respects, as she is now first in the excellence of her water supply.


Deck Line
6th.W.L.
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6th.W.L.
5th.W.L.
4th.W.L.
3rd.W.L.
2nd.W.L.
1st.W.L.

DESIGNING A STEAMER.

BY H. C. PEARSONS, OF FERRYSBURG.

Believing that the subject of ship-building is fairly entitled to the attention of the civil engineer, I venture to present some ideas concerning so commonplace a thing as the designing of a small steamer, with its machinery, and to make some elementary and practical remarks concerning them. Such a matter is too frequently disposed of with as little thought, or with as little scientific knowledge as would be given by a farmer to the building of his cart or sled.

For the benefit of those not acquainted with ship builders' work, I offer the following:

Definitions and Explanations.—The ship-builder, like the architect, has three "plans" on which to represent his work. The ship, when upright transversely, is said to be on an *even beam*; when upright longitudinally, she is on an *even keel*, and when upright both ways, is supposed to be intersected by planes parallel to the surface of the water. Such planes are called *water planes*, and their intersections with the surface of the vessel are called *water lines*. These water lines are analogous to the contour lines of topography. The projection of these lines, together with that showing the outlines of the deck, onto the horizontal plane, constitutes the *half breadth plan*.

In like manner, the intersections of the vessel, by longitudinal vertical planes, are projected on to the midship longitudinal, vertical plane —called also the plane of symmetry—and constitute the *sheer plan*; their intersections with the surface of the vessel being called *buttock lines*.

The vessel is also supposed to be intersected by transverse vertical planes, at right angles to the plane of symmetry. The sections made by these planes are called *frame sections*, and their intersections with the surface of the vessel, *frame lines*. By revolving the frame sections 90° about their vertical axis they are seen in area, and constitute the *body plan*, shown on the sheer plan.

All these fore and aft lines, with others, whose planes are oblique to those mentioned—and called *diagonals*—are drawn for the purpose of determining graphically the forms of those frames intermediate between those given in the plan.

A practical example will claim our attention. We will suppose we are called upon to design a small steamer suitable for the coasting service on the Lakes, for passengers and light traffic; also to fix the amount and proportions of her machinery, under the following conditions: Vessel to be a propeller; length on water line, about 150 feet, with as much beam as may be consistent with fair sailing properties; draft of water, when on an even

keel, not more than 10 feet, and to have an ordinary working speed of 15 miles per hour. From a consideration of the above conditions, we see that our problem is: 1. To determine the beam of the vessel. 2. To determine the fullness or fineness, compatible with the conditions of draft and speed imposed. 3. To determine the amount of power required. 4. To determine the proportions of the machinery—such as amount of grate and heating surface in boiler, volume of cylinder, with length and diameter of cylinder, diameter and pitch of propeller.

Beam.—With regard to the first condition, we may remark that large vessels require less beam for a given length than do small ones, for the reason that while the effect of a weight or force to disturb a vessel from the position of an even beam, varies directly as its leverage or distance from the vertical longitudinal plane through the centre of the vessel, the ability of the vessel to withstand such disturbing effect varies as the cube of its beam, the vessels being supposed similar, and similarly loaded.

From one-ninth to one-seventh of the length has been found a good width for large vessels, while for small ones, one-fourth to one-third of the length is required, the depth being from one-fourth to two thirds of the beam. But ship owners were not slow in learning that great length was not in the interest of economy in the first cost of capacity. Farmers know very well that it requires more fencing material to enclose a given area in a long, narrow field, than in one more nearly square. The science of isoperimetry explains the reason. Ship owners learned that while by great length they reduced, somewhat, one element of resistance through the water, they were increasing the weakness of the ship, in that they could not give depth to correspond with the increased length.

The result is, that the long slim ship is found to be too costly for a given capacity, and the greater beam is gaining favor. Merchants are now in favor of seven to eight beams for the length in larger vessels, while for smaller ones six or five beams are deemed a good length. For special reasons pertaining to the arrangement of machinery and joiner's work, we assume the length of water line as 153 feet, beam 28 feet, and depth of hold, 11 feet, thus making the length about $5\frac{1}{2}$ times the beam.

Fullness.—With regard to the fullness or fineness of the model, I may remark that as the traffic is to be light and the vessel is to have a fair speed—15 miles—our first consideration will be to get the vessel down in the water, for the screw must have a certain amount of disc area, a footing so to speak, in order to afford the necessary resistance for the engine to work upon, precisely as a locomotive must have a certain amount of weight in order to afford the bite needful for the performance of her work.

The task of finding the draft of water, the weight of vessel, and amount of power required for a given speed, is of a tentative character, for they are so materially dependent upon each other that most of them become indirectly dependent on themselves, thereby putting them beyond the reach of direct calculation. Thus, with a given thickness of plank, and a given size of scantling in the frame, the draft of water will depend on the leanness or fullness; the immersed surface will depend on

the draft, the length remaining constant; the amount of machinery depends on the area of this surface, which in turn depends on the amount of machinery; also the diameter of the wheel depends on the amount of power the engine is to develop, and the draft of water, which depended on the model, must also depend on the wheel, for the wheel must be under water.

From the above considerations we find it necessary to assume as many things as we can. We will assume that we will have a compound engine, a boiler pressure of 100 pounds of steam, with steam enough to secure a piston speed of 500 feet per minute; we will provide cylinder space sufficient to expand our steam to seven volumes, besides the conditions already imposed, that we shall have a speed of 15 miles, with a maximum draft of 10 feet on an even keel.

Corresponding to the above imposed conditions, we are to find the diameters of the two cylinders; the amount of grate area and heating surface in the boiler, nd the diameter and pitch of the wheel, for, contrary to the opinion of too many ship owners and engineers, *the length of stroke of a marine screw engine, depends on the pitch that can be given to the wheel* within the limits of economy.

First, with regard to the amount of power required: Having shaped the lines of our model, according to the best of our judgment, to have the desired draft, when ready for sea, we proceed to find the weight of the displacement to some certain height from the base line; we have assumed the fourth water line, (see illustration) which is 8 feet from the base line, for the purpose of seeing how near we have guessed to the desired form of model. This tentative process must be repeated till we find a result sufficiently near the desired limit for our purpose.

The process of finding the volume of displacement and the centre of gravity of the same, for trim of ship, is analogous to finding the amount of earthwork in a long cut or fill, and the centre of gravity of the same for the purpose of knowing the mean haul, and are best found by Simpson's rules for surfaces and solids, as given in nearly all standard works on ship-building, and as employed by the government in finding the tonnage of vessels. By these rules, and calling our planking 3 in. thick, we find the displacement to 8 feet above the base line to be 421 tons, of 2,000 pounds.

For weight of hull we find the area of surface from centre of keel to top of sheer strake in square feet, by the rules above indicated. Then the mean thickness of timber is found thus: The mean thickness of the frame is the cross-section of the scantling divided by the distance between centres; add to this the thickness of plank, thickness of ceiling, and mean of the sectional area of keelsons and clamps, and we have the total thickness—in our case 12 inches, which of oak, at 65 pounds per cubic foot, including the iron used for fastening, gives a total of 101 tons; in a similar manner for deck and bulwarks, 31 tons; for joiner's work and equipments, 20 tons, making a total of 152 tons for one-half, or 304 tons for entire hull, without machinery, leaving a remainder of 117 tons for machinery and cargo.

Power.—Seeing that we have an abundant displacement for our hull and machinery, with something more than a foot for cargo, we proceed to find the amount of power required, which has been found to depend chiefly on the amount of surface immersed, and to a small extent on the form of model, in the angles which the water lines make with the centre line of the vessel forward. According to Rankine, Russell, and other experimenters, the resistance per square foot of surface, for a velocity of one knot per hour, is for

Smooth copper surface	.007 lb.
Wood surface, planed and painted	.010 lb.
Wood surface from the saw	.016 lb.
Surface foul with weeds, moss, etc.	.04 to .05 lb.

which we represent by the coefficient k.

That part of the resistance due to model, Mr. Rankine tells us, is "*Four times the mean of the squares of the sines of the maximum angles,*" which the water lines make with centre line of vessel forward. In our example, (see illustration) the angles are for

1 water line 5° log. sine^2	= 3.88060, natural number	.00759
2 water line 9° log. sine^2	= 2.38866, natural number	.02447
3 water line 11½° log. sine^2	= 2.59932, natural number	.03975
4 water line 13° log. sine^2	= 2.70418, natural number	.05061
		4).12242
Mean of the square of the sines		.03060

which multiplied by 4, is .1224. This decimal is not unfrequently as high as .25,—showing that we have our vessel sharp under water, notwithstanding the great beam.

To this decimal, which we will call x, and which is constant for the same vessel, Mr. Rankine adds 1, and calls the $(1 + x)$ a coefficient for the *augmented surface*, the object being to represent the total resistance in terms of that for the surface immersed. Then, representing the immersed surface by S, the coefficient for augmentation by $(1 + x)$, the coefficient for friction of surface by k, the velocity in knots per hour by v, the total resistance in pounds by R, and bearing in mind that for moderate speeds, the resistance varies as the square of the velocity, we have Rankine's formula, viz: $R = S(1 + x)\, v^2\, k$.

Multiplying this resistance by the velocity in feet which the vessel makes per minute, and dividing by 33,000, we have the effective horsepower required for the required speed.

The area of the wet surface is found by taking the mean of the girths of the sections, from the centre of the keel up to the load line (see illustration) which we have drawn at a mean height of 8 feet above base line, and multiplying by the length, which should include the wheel and rudder. We find this area to be 4,730 square feet. Our velocity v being in miles, we must reduce to knots, amounting in this case to 13. Then, assuming our coefficient for friction to be .012, which would represent the relative state of a smooth surface, after being some time in water, we have

$$R = 4{,}730\ (1 + .1224)\ 13^2 \times .012 = 10{,}775 \text{ pounds.}$$

That is to say, the direct thrust on the propeller shaft must be 10,775 pounds, or about 5⅜ tons. Then, multiplying this resistance by 1,320, the

velocity in feet, for v = 15 miles, and dividing by 33,000, we have the effective horse-power of the thrust = 430.9, say 431. As our best screw engines yield in useful work only 57 to 67 per cent. of the total power applied, or say $\frac{2}{3}$, we must take $\frac{2}{3}$ of this, or 690 horse-power for the total power to be expended.

Proportions of Machinery.—Diameters of the cylinders will next be considered. Our boiler is proportioned to carry a steam pressure of 100 pounds on the square inch; but suppose we only get 90 pounds and that three pounds of this vanish between the boiler and cylinder, through the vicious habit of throttling the steam; then, adding 14 pounds for the atmosphere, we have an initial pressure of 101 pounds. Multiplying this by 1 plus the hyperbolic logarithm of 7, our expansion factor, and dividing by 7, we have 42.5 = mean cylinder pressure, and deducting 2.5 pounds for back pressure, we have 40 pounds mean effective cylinder pressure.

One inch of piston area under a pressure of 40 pounds, with a velocity of 500 feet per minute, will exert about 0.61 of one horse-power. Divide the total horse-power by this quantity, and $690 \div .61 = 1131$ square inches of piston area for the larger cylinder. Add, say 9 square inches for the half section of the piston rod, and a piston area of 1140 inches results. From a table of areas and diameters we readily find the diameter = $38\frac{1}{8}$ inches—say 38 inches. Then, dividing this diameter by the square root of the factor for the expansion we wish to produce in the large cylinder—say 3, we have the diameter of the small cylinder, thus $38 \div \sqrt{3} = 38 \div 1.732 = 21.94$—say 22 inches for the diameter of the small cylinder.

The power required being known, we are prepared to determine the diameter of the wheel. This dimension is not one that may be assumed at pleasure, or convenience, as our manuals would seem to indicate, but depends on the amount of pressure to be brought upon it. I have never found in our books any other than the "rule of thumb" for this question, and have, therefore, fallen back on my own diligent observations for the past ten years. I have noticed that propeller wheels require for their minimum diameter in feet the cube root of the maximum horse-power the engine is capable of developing, or what is better, *take the cube root of one and one half times the indicated horse-power of the engine as developed in ordinary work for the diameter of the wheel in feet.* This diameter, it is to be observed, is the *minimum.* It may be greater, but *it should not be less.* In our case we have $\frac{3}{2} \times 690 = 1035$, the cube root of which is 10.11, or say 10 feet for the diameter of the wheel.

Furthermore, it is well known that the pitch should not exceed about $1\frac{1}{3}$ diameters; a pitch of one diameter, or thereabout, yields maximum results with regard to economy in the expenditure of power. This rule would give a pitch of 13.3 feet; and, deducting about 15 per cent. for slip, we will have a net pitch of 11 feet, or thereabout. Dividing the distance, 1,320 feet, which the vessel must make per minute, by this net pitch, we have $1320 \div 11 = 120$, the number of revolutions that must be made per minute. Divide the piston speed by this number of turns and we have 500

÷ 120 = 4.16 feet of piston travel for one turn, or 25 inches for the stroke of piston.

Thus, we have diameter of large cylinder = 38 inches; small cylinder = 22 inches; stroke of piston = 25 inches. Diameter of propeller, 10 feet; pitch, 13⅓ feet.

The size of the boiler can now be determined, as we know the amount of steam to be used. We are to have 120 turns per minute; and, expanding to three volumes in the small cylinder (giving a practical expansion in both cylinders of about seven,* when clearance is allowed for), the small cylinder having a volume of 5½ cubic feet, we should use 120 × 2 × ⅓ × 5½ = 440 cubic feet per minute. To this should be added at least 30 per cent. for reserve, in emergencies, and to cover clearance and waste, making 570 cubic feet. Steam of 100 pounds pressure weighs 0.23 pounds per cubic foot, whence, for one hour we require 570 × .23 × 60 = 7866 pounds of water to be evaporated.

Experience informs us that we may vaporize any amount from 40 pounds to 400 pounds per hour per square foot of grate area—200 to 220 being an average for good firing; then dividing the total weight of water to be vaporized by the efficiency, say 200, of one square foot, we have 7866 ÷ 200 = say 40 square feet of grate area, which the boiler-maker quickly tells us can best be had with two boilers about 5½ feet diameter and 12 feet length.

ADDENDA ON THE PROPELLER.

The law by which the resistance or *holding power* of the wheel varies with the diameter is not generally understood. The result is that small steamers are almost invariably furnished with wheels too small, while the larger ones are as often furnished with those unnecessarily large. The former require too much pitch to work off the power of their engines, while the latter have a needless amount of friction to overcome.

The following considerations will enable us to determine the law of the resistance: We know that the wheel acts on a volume of some form, though, of course, we do not know what that form is. But we judge from analogy, that the form is the same, under the same conditions. And we know from geometrical considerations that the weight or resisting power of the volume acted upon varies as the third power of the diameter of the surface acted upon by the wheel. Whence, to find the relative resistance or holding power per unit area in the disc of wheels of different diameters we have simply to divide the third power of their respective diameters by their second powers, when we have the first power. Hence the law:

That the *holding power, per unit of disc area, varies as the diameter.* That is to say, a unit of disc area in a 10-foot wheel has ten times as much holding power as the same unit in a 1-foot wheel, or five times as much as the same unit in a 2-foot wheel.

It is by virtue of this law that large wheels are enabled to work off such

*NOTE.—It is convenient, with a slide valve, to cut off steam at from ⅓ to ⅔ of stroke, or to expand from 1½ to 3 volumes. We must expand in the small cylinder to 2½ volumes. The above limits will include this factor and give us a little latitude each way; hence *three* was chosen as the maximum limit of expansion in the small cylinder, in order to get a mean expansion in both cylinders to seven volumes.

a vast amount of power. The steamer "Alaska" works off 11,000 I. H. P. on a wheel 22 feet diameter, and 23½ feet pitch, while vessels working off the tenth of that amount of power, require wheels nearly half that diameter.

The disadvantage of a high pitch may be seen from the following investigation: It may readily be shown that the centre of the work of propulsion, or centre of pressure of the blade, is at .84 of the length of the blade, from the centre of the wheel. We know the cosine of the pitch angle is the measure of the useful work, relatively to the total work, whence we know that the versed sine is the relative measure of the lost work.

If, then, we divide .84 of the circumference of a wheel into the diameter, we shall have the tangent of the pitch angle at the centre of work, for a wheel having one diameter for the pitch. Thus, $1 \div (.84 \times 3.1416) = .37878 = \tan. 20°, 45'$, the versed sine of which is .0648. In this manner is the following table computed, for wheels varying by ¼ diameter in their pitch.

The mean pitch-angle at the centre of effort corresponding to				Differences.
1	diam.	= 20°.45′	—ver. sine = .0648	.0314
1¼	"	25° 20′	— " = .0962	.0343
1½	"	29° 36′	— " = .1305	.0359
1¾	"	33° 32′	— " = .1664	.0365
2	"	37° 09′	— " = .2029	

By taking the difference of the above versed sines, consecutively, we find a regular falling off of something over 3 per cent. of the useful work, for every addition of ¼ diameter to the pitch of the wheel.

One more idea concerning the pitch of the wheel, and I am done. I wish to inform you that the world has not yet learned how to measure the pitch of our modern propeller wheel In view of the vast amount of the best mechanical talent the world can afford that has been given to this question, this may seem a broad assertion to make.

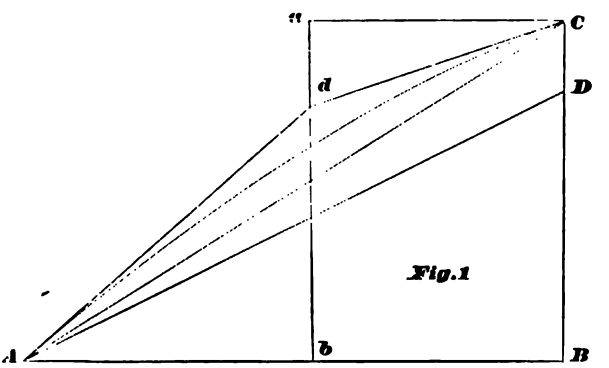

Fig. 1

The accompanying cut will illustrate the present method of finding the pitch of wheels. The curve *A C* represents the working face of wheel

blade, having a gaining pitch, the curve being that of a parabola, or supposed to be such, *C* being at the leading edge of the blade, and *A* at the after edge. Then if *A B* be bisected in *b* and the perpendicular *b a* be erected, and tangents be drawn through the points *A* and *C*, they will intersect in *d*, on the perpendicular. *B A d* is the pitch angle for the after edge of the blade, and *b d* is the pitch for the after half of the width of blade. Also *a C d* is the pitch angle for the forward edge of the blade, and *a d* the corresponding pitch for the forward half of the width. Then *a b* = *B C* is the mean of the pitch for the two edges of the blade; thus *B C* is the mean pitch, and *B A C* is the pitch angle, corresponding to the width of blade; then setting down the slip—usually from 10 to 30 per cent. —from *C* to *D* we have in *B D* the net pitch, which in all well-behaved wheels, is less than *B C*. But we not unfrequently find the point *D forward* of *C* and *BD* greater than *B C* when we have the phenomenon of a negative slip.

It would be amusing to review the different theories that have been brought up and urged to explain this amusing absurdity, even by learned professors.

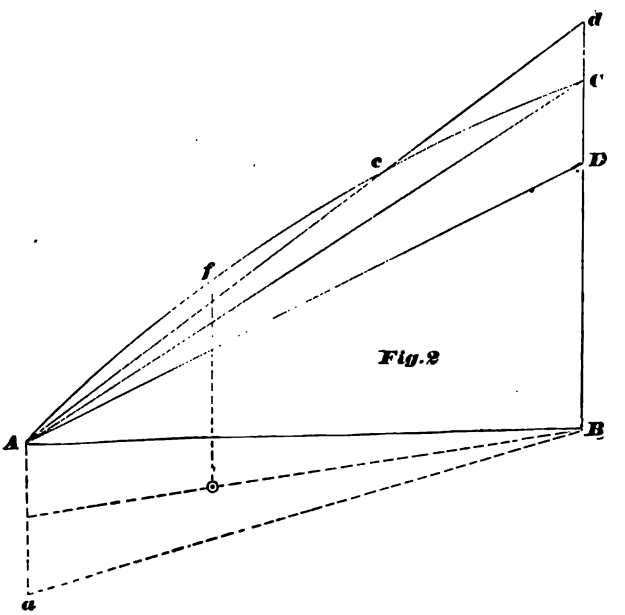

Fig. 2

In Fig. 2, as before, the curve *A C*, represents the working face of the blade, and suppose it of a form best adapted to the work. Then a tangent to the point *C* will be parallel at that point with the direction of the blade, and the work or pressure of the blade at that point will be zero. As the blade advances in its revolution, the inclination to its line of motion, and

consequently the *intensity of pressure increases* from *C* to *A*, where it is at its maximum. Whence the work of propulsion may be represented by a triangle, with vertex at *B* and base at *A*. Since the center of work is at the centre of gravity of the triangle the line *A d*, forming the pitch angle with *A B*, must be parallel with a tangent through *f*,—*A f* being ⅓ *A C*. Hence we have an easy method of finding the true working pitch of a wheel graphically. Take the point *c* at two-thirds of the width of blade from the after edge and draw the secant *A c d* intersecting the perpendicular *B C* produced in *d*. *Then is B d*—and not *B C* –*the true pitch*, corresponding to width of blade; *B A d*, not *B A C*, is the true pitch angle, and the point *D* may be forward of *C* without showing a negative slip.

Any and all wheels that show what is called a *negative slip*, *i. e.*, that drive their vessels faster than their mean pitch would indicate for them, are wasteful agents for the application of power. A portion of the forward edge of the blade takes water on the *forward side*, thereby doing *negative work*, and the vessel is driven forward by other portions of the blade, *in spite of* that portion working backwards.

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Principal Assistant Engineer, P. H. & N. W. R. R.

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WENZELL, ANDREW.....43 Elizabeth street, Detroit, Wayne "
U. S. Assistant Engineer.

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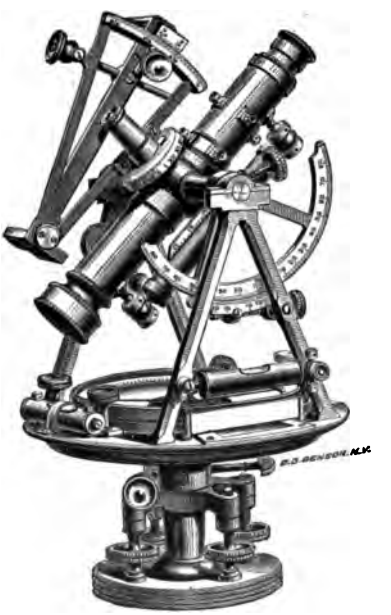

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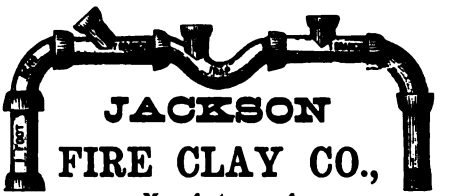

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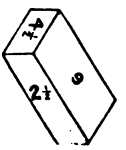

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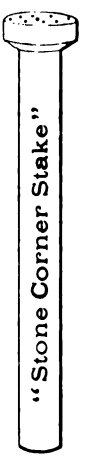

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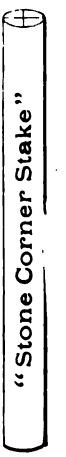

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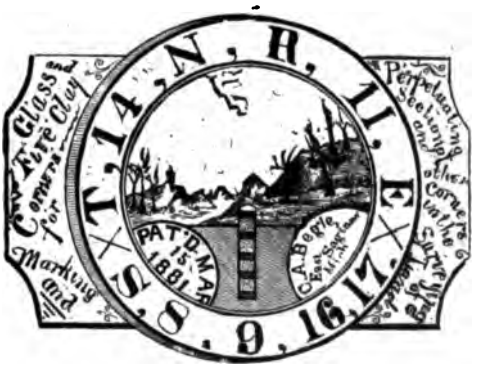

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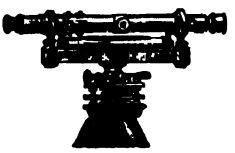

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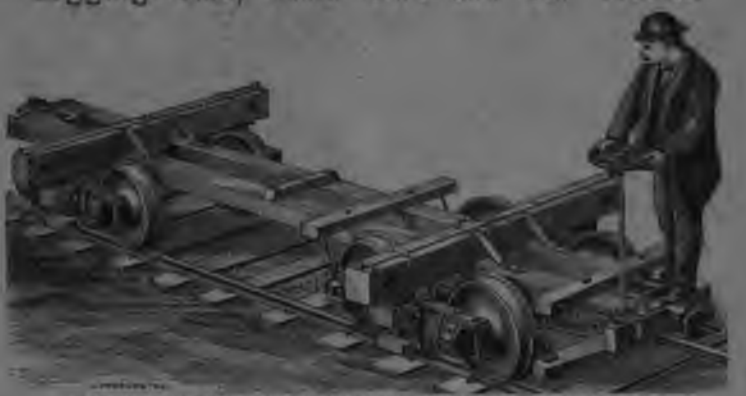

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PROCEEDINGS

— OF THE —

MICHIGAN

Engineering Society,

— AT ITS —

SIXTH ANNUAL CONVENTION,

HELD AT

LANSING, FEBRUARY 17, 18, 19 AND 20, 1885.

SEVENTH MEETING WILL BE HELD AT ANN ARBOR, SUBJECT TO CALL OF EXECUTIVE COMMITTEE.

PUBLISHED FOR THE ASSOCIATION.
AT OFFICE OF THE AMERICAN ENGINEER,
CHICAGO, ILL.

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ERRATA.

Page 22. The figures reading 36.241 at bottom right hand of Map *should* read 66.241.

Page 35. In list of newly elected members, the fourth name on the list, which now reads Barber *should* read Barnard.

Page 40. On map lower left hand section now reading T. 16 N, R. 12 W. Sec. 6, *should* read T. 16 N, R. 12 W. Sec. 12.

Michigan Engineering Society.

ORGANIZED AS MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS AT LANSING, MARCH 25, 1880.

OFFICERS, 1885.

PRESIDENT, PROF. JOSEPH B. DAVIS, of Ann Arbor.

VICE PRESIDENT, GEO. E. STEELE, of Traverse City.

SECRETARY AND TREASURER, PROF. R. C. CARPENTER, of Lansing.

EXECUTIVE COMMITTEE.

PROF. M. E. COOLEY, of Ann Arbor. C. E. HOLLISTER, of Laingsburg. W. S. RUSSEL, of Detroit.

STANDING COMMITTEES.

Publication—PROF. C. E. GREENE, of Ann Arbor.

Manual—F. HODGMAN, of Climax. G. E. STEELE, of Traverse City. PROFESSOR C. F. R. BELLOWS, of Ypsilanti.

Land and City Surveying—A. J. TEED, of Cadillac. H. F. BEAN, of Jackson. H. D. BARTHOLEMEW, of Lansing.

Railroad and Bridge Engineering—WM. B. SEARS, of East Saginaw. A. L. REED, of Port Huron. J. J. MCVEAN, of Ionia.

Mechanical Engineering—JESSE SMITH, of Detroit. S. E. JARVIS, of Lansing. C. A. KOEHLER, of E. Saginaw.

Hydraulic and Mining Engineering—C. H. V. CAVIS, of Marquette. G. D. WALCOTT, of Jackson. H. B. STURTEVANT, of Ishpeming.

Sanitary and Drainage Engineering—C. E. HOLLISTER, of Laingsburg. E. F. GUILD, of E. Saginaw. DORR SKEELS, of Grand Rapids.

Rivers, Harbors and Lighthouses—H. C. PEARSONS, of Ferrysburg. J. A. MITCHELL, of Grand Rapids. JOSEPH RIPLEY, of Sault Ste. Marie.

Highways and Highway Bridges—ROB'T E. WILLIAMS, of Jackson. JAMES SANDERSON, of Detroit. GEO. S. PIERSON, of Kalamazoo.

ANNUAL CONVENTION, 1885.

General Remarks.—The Convention was called to order Tuesday afternoon and continued in session until Friday afternoon, Feb. 20.

Considering the severe cold and the snow blockades the attendance was good, ranging from forty to eighty at each session. More interest was probably excited by this meeting than any preceding one, absent members generally writing or telegraphing. The number of new members joining makes the future of the Society very promising.

The Mechanical Engineers had an interesting session on Friday, Feb. 20, and will, no doubt, bring much matter of interest before the Society at the next annual convention.

ABSTRACT OF SECRETARY'S REPORT.

TUESDAY, FEB. 17, 2 P. M.

The Convention was called to order with the President, Prof. J. B. Davis in the Chair.

Mr. B. F. La Rue, of Jackson, was appointed Recording Secretary.

Mr. Wm. M. Whitten, of South Bend, attended the Convention as a delegate from the Indiana Association of County Surveyors and Civil Engineers. By special vote Mr. Whitten was tendered the privileges of the floor, and for the session made an honorary member of the Society.

PROGRAMME.

The following programme was carried out, as arranged:

TUESDAY, FEBRUARY 17, 1885, 2 P. M.

REPORTS OF COMMITTEES.

Report and Suggestions of President.
Report of Executive Committee.
Report of Committee on Manual.
Report of Standing Committees.
Report of Secretary and Treasurer.
Paper—Restoration of Lost Corners. M. S. Cook, C. E., Manistee.

7:30 P. M.

City Council Room. Public Meeting.

Address of the President of the Society, Prof. J. B. Davis—The Engineer; What manner of man is he?

WEDNESDAY, FEB. 18, 1885, 9 A. M.

Paper—Estimating the Amount and Value of Standing Pine Timber. S. S. Hastings, of St. Louis.
Paper—Practical Queries. Answered by I. H. Leavenworth, Saginaw City.

2 P. M.

Paper—Construction of Iron Lighthouses. W. S. Russel, Superintendent Russel Wheel and Foundry Co., Detroit.
Paper—The Separate System of Sewerage. Geo. S. Pierson, City Engineer, Kalamazoo.

7:30 P. M.

Public Meeting. Legislative Hall.

A System of Water Works Designed for Ann Arbor. Prof. C. E. Greene, Ann Arbor.
Pure Water and Pure Air. W. R. Coats, Kalamazoo.

THURSDAY, FEB. 19, 9 A. M.

Paper—Suggestions to Beginners in Land Surveying. Dorr Skeels, Grand Rapids.

Cause of Compass Deviations on Vessels. H. C. Pearsons, Ferrysburg.

Report of Committee on Exhibition of Instruments.

2 P. M.

Maintenance of Way. E. Treadwell, Assistant Roadmaster Flint & Pere Marquette Railroad.

Location of Canadian Pacific, Rocky Mountain Division. F. P. Davis, formerly Resident Engineer, Washington, D. C.

7:30 P. M.

Public Meeting.

Legal Position Occupied by a Surveyor in the State of Michigan. Hon. L. S. Montague, Howell.

Legal Requirements for Village Plats. Hon. Geo. E. Steele, Traverse City.

FRIDAY, FEB. 20, 9 A. M.

Paper—Construction of Chimneys for Steam Works. Prof. R. C. Carpenter, Lansing.

Discussion on Balancing Engines. Jesse Smith, Detroit; S. E. Jarvis, Lansing.

2 P. M.

Address by M. E. Cooley, of Ann Arbor, Professor of Mechanical Engineering, University of Michigan.

REPORT AND SUGGESTIONS OF PRESIDENT.

Gentlemen of the Michigan Engineering Society:

I address you with words of congratulation. The new name of this Society indexes its aspirations. The changes in its constitution emphasize them. I confidently expect to see them all fulfilled, and more yet, not thought of or felt. I look to see this Society gather into its membership the mass of "Persons engaged, or actively interested, in engineering pursuits," in this State. This Society, I believe, is to go on in its work, embracing, more and more, the broad field of engineering pursuits in Michigan. The membership will increase. It will be, increasingly, drawn from numbers following widely differing branches of work. Room will be made for any who are earnest seekers after the truth, however different their pursuits may be,—however unknown, or unexplored, by others engaged in engineering. Our organization will be modified, enlarged, or recreated, to receive engineering truths. And, while all this is done, I feel sure none will ever cease to honor the band of faithful surveyors who first made all this possible. There will always remain here the same friendly and helpful spirit that they first furnished. They, too, must always take a certain honorable pride in originating so potent a work and so influential an organization. Though the time may soon come when the diversity of pursuits and interests may require separate sessions of different classes here, that will but give utterance to the broad and deep feelings of a common interest in the welfare of us all that unites our members so firmly to-day. There will be many members but one body,—but one heart. We shall never forget that the unseen things are the eternal ones.

I will briefly indicate to you some things that I think should receive your attention.

1. The extension and perfection of our work and the increase of our membership. To accomplish these related objects I hope our standing committees will each be led to summarize briefly as complete a list as possible of the enterprises in the State in its particular field. The object of these summaries would be to furnish us each year, or

each meeting, with as complete a survey of our engineering work as may be. I think they should be perfected as rapidly as possible so as to give us a proper basis for future reports. This process will give us a knowledge of the experiences of others. The work and intercourse thus made necessary will extend interest in us and thereby draw to us those communicated with. I am sure everyone will cheerfully respond to any inquiries by these committees. The field can be divided amongst the members and the labor lessened. But labor must be done if results are reached. I did what I could to interest some of our members in this work as a preparation for this convention, and I feel sure not without success, as far as time was concerned. I also recommend a consideration of the organization of these committees, perhaps the division of the work of some of them among two or more. I think some new ones should be raised and set at work. I respectfully suggest as additional important subjects, Rivers, Harbors, Lighthouses, Vessels, and Iron Works.

2. Legislation. Subject to the present condition of our statutes, I think we should ascertain if there be laws covering the points suggested below, and if there are none, or imperfect ones, this Society should use its influence to provide them, as many of the evils referred to are serious.

a. Highway Bridges. There should be laws providing for the punishment of all those in anyway responsible for the erection or perpetuation of the death traps throughout the State, far more easy and certain of execution than anything now in reach. This matter is quite as important as kerosene oil and doctors.

b. Railroads. They should be required to make possible connections for the convenience of the public from whom they receive their franchises and not be allowed to purposely avoid them to satisfy business spites. Also to use better car coupling devices. There are plenty of them that are far better than any common now. And the courts have begun to hold that the companies are in some measure, at least, responsible for injuries to employes.

c. Surveys. The following records should be required by law to be made at the Office of the Register of Deeds, at least:

Changes of streets or highways affecting boundaries of property.

The locations of bridges, culverts, and the like, that have been and are frequently used as land-marks.

The location of any natural features changed by public act, previously used as a land mark, before and after the change. Such are

streams, ledges, and water levels. The same should be done for all similar matters, to be determined by a comparison of experiences.

Descriptions of nothing, or less than a full description, should be excluded from the records.

Provision should be made for resurveys over extended areas where corners are lost, in towns and cities, as well as elsewhere. I have managed this in my own experience by common prudence, but I can easily perceive cases where far more is needed,—something that shall be authoritative.

As to Town Plats. Only the land actually staked out on the ground should be received for record. Also, provision for the survey of town sites by non-resident surveyors.

8. I think we can do much good by extending, to individuals, by conservative and judicious action, carefully considered, courteous attentions, whether in the form of honorary distinctions, or not, as the Society shall determine.

4. I hope the form and appearance of our published proceedings will not be permitted to decline in any respect. To make sure of this I earnestly desire to see the same committee on publication retained.

5. I respectfully suggest as the place for our next annual convention, Ann Arbor,—where, I am sure, we will be heartily received.

I respectfully leave these brief and very imperfect and incomplete suggestions before you to be freely disposed of as you see fit.

On motion, the suggestions in the President's address were referred to Messrs. Appleton, Hastings, and LaRue, who reported later, as follows:

Mr. President and Gentlemen:

Your Committee appointed to divide and refer the subjects mentioned in the opening address of the President to appropriate committees beg leave to report the following:

That so much as refers to an enlargement of the scope of the Society be referred to the Special Committee on Suggestions by the Secretary, viz: Messrs. Steele, Greene, and Hodgman. So much as relates to rivers, harbors, lighthouses, etc., be referred to Messrs. H. C. Pearsons, Greene, and Carlton. So much as relates to legislation respecting highway bridges be referred to Messrs. Sears, R. E. Williams, and Steele. So much as refers to legislation in regard to railroad connections be referred to Messrs. Watkins, Leavenworth, and Bean. So much as relates to recording the removal of permanent land marks be referred to Messrs. Beden, Hodgman, and M. S. Cook. So much as relates to publishing the proceedings be

referred to Messrs. Greene, R. C. Carpenter, and the President. On the matter of resurveys, etc., that it be referred to Messrs. Skeels, Bartholemew and Bean, and on the recording plats of towns, Messrs. Yocum, A. J. Teed, and Guild.

Respectfully submitted,

WM. APPLETON,
S. S. HASTINGS.
BENJ. F. LARUE.

On motion, at the close of the evening session, the committees were appointed as suggested.

The following are the reports from these special committees, as presented when opportunity allowed during the session:

REPORT OF COMMITTEE ON THE DESTRUCTION OF LANDMARKS.

To the President and Members of this Society:

Your Committee, to whom was referred that part of the president's address which refers to the destruction of landmarks, would respectfully report that they have had the matter under consideration and would favor legislation on the following points:

1st. Farmers, in clearing their land, should be required to preserve their landmarks.

2nd. Surveyors, in surveying for roads, should be required to fix permanent monuments at all government corners, and on angling roads, at all points where the line of road intersects a section line.

3rd. All overseers of highways should be responsible for the preservation of monuments when constructing or repairing roads, and if any monument seems to be missing within the bounds of a highway, the overseer, before beginning work on any part of said highway, shall procure the services of a competent surveyor to establish such monuments.

4th. Proper penalties for violation of these acts, or removing any established landmarks.

SETH N. BEDEN,
F. HODGMAN,
M. S. COOK.
Committee.

REPORT OF COMMITTEE ON RE-SURVEYS.

Gentlemen:

Your committee, to whom was referred that part of our worthy president's report and suggestions referring to re-surveys, have had the same under consideration and beg leave to report that in their opinion these

suggestions embody the true scope and end of our association—a thorough and studied discussion of such questions as may be offered, which cannot be done well by committees created on the spur of the moment, who have no time nor opportunity to prepare themselves to make a proper report.

We therefore recommend that the number of our standing committees be increased, whose duty it shall be not only to prepare a report on their subject, but also to prepare themselves to discuss and answer all questions pertaining to their department.

DORR SKEELS,
H. F. BEAN,
H. D. BARTHOLEMEW.
Committee.

REPORT OF COMMITTEE ON RECORDING PLATS OF TOWNS AND VILLAGES.

Mr. President and Gentlemen:

Your committee, to whom was referred the subject matter of recording plats of towns and villages, as recommended in the president's opening address, beg leave to respectfully submit the following:

We would most respectfully request Hon. Geo. E. Steele to embody these requirements in his remarks on "Legal Requirements for Village Plats," as per printed programme.

JOHN K. YOCUM,
A. J. TEED,
E. F. GUILD.

REPORTS OF STANDING COMMITTEES.

The following standing committees reported on the various subjects referred to them as follows:

The Committee on Land Surveying, through its chairman, Mr. John J. Watkins, of Lapeer, made the following report:

Mr. President and Members of the Michigan Engineering Society:

Reluctant as I ever am to appear upon the public rostrum in addressing my fellow-citizens it is not without a degree of diffidence that I even now appear before you,—my brothers in area development and linear architecture—to make the annual address and report to be expected at this time from the chairman of the standing committee on land, highway and city surveying. And yet as I stand before you I feel a thrill of joy pervading my person in offering congratulations upon the progress we have made since our organization, and especially in the new departure we are this year opening up in the different departments of sectional developments pertaining to the various phases of engineering science.

It is peculiarly fitting for us at this time to rejoice, since *this* year is the *Centennial year* of the adoption by our government of the rectangu-

lar system of division of the public domain; a system unequaled by any other in the civilized world, for ease and facility of description, for rapidity of location, and for the readiest maintenance of the boundaries of each tract or parcel. This system was adopted by act of Congress, May 20, 1785, but not in its present perfection; many alterations and improvements have been made since its introduction. Its author so far as known was Thomas Jefferson; at least the credit is usually ascribed to him for its introduction by our government, he having been the chairman of the committee in Congress for determining the location and sale of the public lands; and yet, one hundred years before, lands had been surveyed in rectangular plats. The system as now developed requires that initial points be first established; these are located from previously known points by triangulation, having their latitudes and longitudes accurately defined, and from these points are projected principal meridians and base lines, taking their names either in numerical order or from some local name of place through which the meridian may be made to pass. Of these, up to the last report at the close of 1883, six are known by their number as "first," "second," "third," principal meridian, etc., and twenty-four others named from some local cause. These do not include the meridian between the states of Pennsylvania and Ohio from which the surveys in Ohio known as the "Seven Ranges" were projected under act of May 20, 1785, of the Congress of the Confederation. In addition to these principal meridians and base lines, the system as at present constructed requires for longitudinal departures guide meridians, range lines and section lines; and for latitudinal are required standard parallels or correction lines, town lines and section lines, thus making divisional lines on every side where it is practicable of every square mile of the public domain. In connection with these where necessary are also meander lines to define the sinuosities of our lakes, rivers, bays and bayous, and the indentations of the shores of islands and of shoals; how feasible in its workings, how satisfactory in its results is this system.

From the bases, townships are run and numbered consecutively northerly for four townships or twenty-four miles, and southerly for five townships or thirty miles, at the termination of which standard parallels or correction lines are then run, and from the surveying meridians as established the ranges of townships are numbered east and west for four consecutive ranges of townships, at which termination guide meridians are run. Act of May 20, 1785, provided that the first line running north and south should begin on the Ohio river at a point due north from the western terminus of the line run as the south boundary of the state of Pennsylvania; and the first line running east and west should begin at the same point and extend through the territory. In these initial surveys only the exterior lines of the townships were surveyed, but the plats were marked into subdivisions of one mile square numbered from one to thirty-six, commencing with number one in the southeast corner and ending with number thirty-six in the northwest corner. Mile corners were established on the township lines. This region now a part of Ohio was usually known as the "Seven Ranges." Act of May 24, 1824, provides that whenever in the

opinion of the President of the United States a departure from the ordinary mode of surveying land on any river, bayou, lake or water course would promote the public interest, he may direct the Surveyor General of the district in which such lands are situated, under such rules as the President may prescribe, to cause such lands to be surveyed into tracts of two acres in width fronting on any river, lake, bayou or water course by forty acres in depth, thus accounting for many of the long and narrow farms found fronting on rivers, bays, etc. Turning to our own state we find the meridian governing the surveys in Michigan is known as the "Michigan meridian," its longitude being 84° 19′ 09″, west from Greenwich with a base seven miles north of Detroit, and that known as the "first principal meridian," dividing the state of Ohio and Indiana, being in longitude west of Greenwich 84° 51′, leaving the Michigan meridian east of the so-called "first principal meridian" 31′ 19″. Michigan from its first erection as a territory has now become an octogenarian, being first set off as a separate territory, January 11, 1805.

The rectangular system at its adoption was undoubtedly an outgrowth arising from the knowledge of the confused and irregular methods before in use, the difficulty of defining tracts of irregular form in conveyances and of determining and maintaining their boundaries, and the consequent litigation arising therefrom prevailing in many of the colonies at that time. These were matters of general knowledge and absorbing interest to Congress.

The earliest surveys in Michigan were made in 1812 by Aaron Greely under Jared Maxfield as surveyor general. Since that time the entire state has been brought under the control of the compass and chain for its primitive divisional purposes. That work has been done; and as a whole, considering the many difficulties and discouragements under which it was executed, I think we may say remarkably well done. Let us so pass it to the credit of those early pioneers, notwithstanding in many cases grave and exceedingly important errors and discrepancies exist, but let us not be disposed to attribute all of these discrepancies to mistakes or errors in field work. It remains for the surveyor of to-day to prove himself a skillful architect of courses and lines, and what is far more necessary, an expert detective of the footprints of the past as well as an able executive and faithful historian of the present; if divergencies were made, competent to delineate where they were made; if errors exist, adequate to the task of deciphering how they were made and, infinitely more important, where they were made, and able to apply the corrections in their just quantity and in their proper places.

Before any survey can be made, whether of retracement merely or for subdivisional purposes, the location as a starting point or points is necessary of some one or more of the original government corners. These always should be proved up either from the original government field notes or by the subsequent notes of him who had previously proved them up; and right here is a point of interest and solicitude, for it is often the source of much error and the consequent litigation arising therefrom. Do not take a corner because acquiesced in, made by some previous sur-

veyor, without his verification as a perpetuation of the original, or of proving it up for yourself; while such corners or lines may be well enough for the adjacent owners if consenting thereto, they are never, if wrongly placed, the proper points from which to determine the boundary lines or corners of non-adjacent proprietors; their rights are not confined to, nor are they to be controlled by the agreement of other parties as to a corner or a line, but their interests are only to be subserved by finding the locus of the true government corner and correct lines proceeding therefrom. Here I take it that I am not at variance with Chief Justice Cooley, who says "we are not to unsettle neighborhoods by discarding old lines and corners long acquiesced in;" for, as I said before and as he admonishes, let the old lines and corners remain if need be for the maintenance of peace and harmony and the special accommodation of the immediate adjacent neighbors reposing such confidence in their location. But ever remember that such old corner or old line, if wrongly set or placed, has no lot or part in, and bears no relation to the proper subdivision of a section or sections contiguous thereto. Before proceeding therefore to the subdivision, be sure your section corners and quarter posts are properly set and well authenticated as the originals by the verifications of your predecessors.

But I think I already hear the inward breathings—what if the corner from which to begin is lost? Pshaw! ninety-nine times in a hundred the corner is not lost to an expert, but only hidden from the view of the novice; and right here comes in your ability as a detective to find that which was said to be lost. Be assured that unless at plowings and scrapings upon a hillside or roadside, or at the deep burnings of swamps or marshes, some evidence almost always remains to fix the locus of the missing corner, and even at the plowings and scrapings of the hillside or roadside seldom is it even then that all vestiges of evidence are removed.

The too ready conception that a corner is lost and the yielding to such impressions precipitate the setting of erroneous corners and augment the embarassment of those meritorious surveyors who are really skilled in their profession. Many indeed have been the times when called upon to settle the disputes between the works of previous surveyors, or to make some subdivision myself, that I have found from one to six of the eight government corners of a section misplaced, and in some instances as high as three corner stakes all designed to perpetuate the same corner, not one of which indicated the true government corner, and were at variance from the true corner by from one foot to between four and five rods. The last mentioned distance had been set by a surveyor in practice six years as a county surveyor in this state, and previously practicing as such in an eastern, or rather in one of the middle states; and this was set as a section corner and on a range line at that. Have there been any bigger blunders committed in our original surveys than this one? I think not. But do not flatter yourselves that such errors are confined to a single county. I find more or less blunders, or mistakes, or errors, whichever you please to call them, in adjacent counties, partaking of the same faults, but varying only in degree. Let me refer to one more instance and I have

done reciting errors. Being called to subdivide a section, in proving up seven of the eight section corners and quarter posts six were proved beyond question to be wrongly set and the original place for every one found and the stake properly adjusted. Now, are the experiences above cited worse than others find who are well versed in their work? I hope so, but yet fear not; then, what does it argue? Certainly, that poor work has been and is being done by others than the original government surveyors. If this be so, what is most assuredly needed? That more knowledge, more skill, more honesty of purpose, more care, more precision are required and certainly should be demanded and as assuredly rendered, and corresponding compensation follow.

But how may one find a missing corner? Let me go back a little and show in what the different kinds of errors consist, where they are made and how they are made. I am aware that this ground has been trod upon by others, and yet perhaps some things which I may say may be new and of interest to many.

1st. Errors in direction are made in the field by the surveyor, by writing down S(outh) for N(orth) and E. for W., or *vice versa*.

2nd. By reading the limb wrongly, adding the extra degrees beyond a delineated figure, instead of subtracting, as 32 for 28, or 56 for 54; or they may have been transposed in setting down, 23 for 32, or 34 for 43.

3rd. By neglecting to write down at the time and calling upon memory to supply omissions.

4th. By not sufficiently allowing the needle to settle, or bluntness of the needle pivot, or the pivot having a hair point and turned by the weight of the needle on a sudden jar, and many more. So much for the faults of the surveyor in the field. On getting into camp at night and looking over the field notes of the day, some of the figures may have become blurred from storm or other causes and the surveyor re-marks them as he thinks they were; or he finds he has failed to note down some distance, or course, or the kind of a witness-tree and its diameter, and he does it now from memory, and probably makes an error here, or possibly more than one. And the chainmen come in for their share of the errors and these are the more important: mis-tallying, counting from the wrong end of the chain, mistaking the checks or tags at the different parts of the chain, calling the half chain a full one, not keeping the pins plumb, or the chain not in complete contact with the pins, or the chain itself being too long or too short; these are fruitful sources of error.

Now, if we measure a section line where a quarter post is missing and desire to re-set it in place, we should very carefully note the distance to our first landmark given in the field notes and compare the distance as given with what we find it, and then and there determine, if possible, how the difference, if any, was made; if slight, it may have arisen from one of the minor causes—from failure of contact of chain and pins, or want of plumbing the pins, or both, or from the length of the chain; if in excess of what such discrepancies should lead to, try and ascertain if counting from the wrong end of the chain will not account for it, or by adding or

subtracting ten or multiples of ten of the tags on the chain; but if the error amounts to or is in excess of a chain or number of chains, this, as well as the others, must be carefully noted as affecting the probable location of the quarter post. When arriving at the place where the quarter post should be found, look carefully for its location before proceeding farther (of course your tally stakes have been set in line); if not found, continue, noting and comparing distances, to the end of the line. You are now prepared to form some quite correct idea where to look for the missing post. After eliminating such errors as you think were probably made, determine where your forty chains, or the otherwise proper distance should come; re-measure the last half of the distance, making allowances for the discrepancies as they have appeared. Set your temporary stake. There are usually eight things to witness the corner: 1. The two bearings to the witnesses. 2. The two distances. 3. The two kinds of trees used as witnesses. 4. The two diameters of the witness trees. If no disturbance has taken place by fire or the hand of man, and your judgment and reasonings have not misled you, some one or more of the evidences ought to be found.

Now commences the search. First, seek the kind of trees of the proper size, allowing for growth. Second, their relative positions and distances. If either one be found, set at that one, reversing the course, and set a pin at the proper distance, where place your instrument and seek for the other, or the chain alone may be used if you can approximate the courses. If all things agree, the place of the stake will be readily found; if not, you may be compelled to review and try some of the various means for detecting the sources of errors of course or errors of distance; but in all cases before making the search be reasonably sure that you are approximately near the desired spot by testing all measurements possible to be made. In seeking for the stake remove carefully all debris not connected with the search that may be upon the ground sufficiently to have a good opportunity for investigating. Next, remove the sods, if any; then carefully hoe away, or remove with the spade or shovel, the surface earth an inch or so in thickness, and remove it farther than would be necessary if all things were recorded correctly; proceed in this manner to the desired depth, and usually, if you have properly located the spot, you will either find the stake or observe as you proceed deeper and deeper the discoloration imparted to the earth by the decayed stake, or possibly the hole, with only the web-like fibres of the long since decayed stake. But suppose all these appliances fail and you find the line too long or too short, by one or more chains and odd links; do not suppose that you are then immediately to divide the line proportionately to the given distances; not so, by any means; now is the time for going slow and bringing into requisition your ability as an expert, and testing the profundity of your knowledge and the fertility of your expedients and resources. Is the line one, two, or four chains and a given number of links long or short of the given distance? Consider what effect would be made in harmonizing the records by taking a 3 for a 5 or an 8, a 7 for a 1 or a 4; as such errors are sometimes made in books of accounts, it is possible they might have been made here

by transcribing; or try the methods before mentioned for reconciling the errors, and in many cases by patient investigation you will be rewarded by discovering where and how the error was made and be enabled to make the proper correction and suitably adjust the line to its legitimate proportions. But suppose you even fail here in arriving at any conclusions to satisfactorily solve the mystery, are you then to give it up? No, not yet. Now, proceed along the line both ways from where you set the temporary stake to a little more than the error in measurement of the whole line, and most minutely examine the entire ground for evidences of the recorded witnesses, removing the debris as before, but allow nothing to be dug up, or even stirred from its place, having any semblance to the wood of the required witness trees; if by inadvertence any such timber is picked up, cause it to be placed back into its bed in the precise position in which it was found, observing every depression where a tree may have been turned or burned out, and every semblance to a hillock that may give rise to a supposition that the elevation might possibly have been caused by the growth of a tree in that spot; then if such depressions or elevations be found, compare their relative positions and distances, and if you should chance to find them accord fully or to accord sufficiently near so as to apply the before mentioned corrections for errors, begin to investigate the hillocks or depressions by as before gently removing the earth from the surface an inch or so in depth at a time, and presently you will be rewarded, if a tree was ever in place there, by observing the discoloration of the earth, not only where the larger roots were in place, but also the marks of each little rootlet as it branched from the larger ones; and they will be displayed in concentric circles, their forms remarkably perfect, more and more as the scrapings are made deeper, until the entire form of the under side of the stump, with its relative size, appears before you. You are now to pursue the most likely one of its roots to endeavor to find a piece of the wood or bark to determine and prove the kind of timber. All things being satisfactory, mark on the ground a ring the size of the original tree, being careful to place it directly over the same line of root indications, and from this ring set out your course and distance for your stake and proceed to find the other witness in the same way before you attempt to find the place of your stake. You will be surprised to find how readily and how near to the exact spot or place of the original stake you can come, sometimes setting your pin precisely over the long sought place, even when to a casual observer every vestige of evidence has long since been removed by fire or time. When the original corner has thus been discovered and proved up indubitably by the relics of the proper witnesses, with evidences concurring, all chances for disagreement are at an end, neighborhood feuds are quieted and litigations undesired and unknown; you have requited the neighborhood ten-fold more than all the expense involved in the investigation, besides its value in making the balance of the survey. But your responsibility rests not here. You are now to leave a rich legacy to future generations, it may be. You have identified the original bearings; then say so in your minutes, making the abbreviation O. B. I., for original bearings identified. You have found

the place of the original post; make the record, abbreviated, O. C. F., for original corner found. Or, if the original stake was found in place, say S. F. O. P., for stake found in original place. Now, also record the true length of the line and its several parts, its length to all natural marks or prominent objects; in other words, transmit to those who shall come after you a concise but complete history of your findings and the manner of perpetuating the corner, as adopted by you, and the new witnesses and bearings taken.

The same course should be pursued for a section corner; but you have usually four lines and courses by which to make your tests in finding the missing corner, unless it be a standard or closing corner, and then you have double the chances which attend the re-setting of a quarter-post.

With regard to corners extending beyond or falling short of section lines, as we sometimes find them set, it is intended by the U. S. law that the corners shall close upon the said lines as run, and as the township lines were run prior to the section corner being set, the law provides that the lines as run shall be the proper boundary of said township or section (see Act of Feb. 11, 1805), and although the section post may fall short of, or extend beyond said town line, the proper corner of the section it was designed to mark extends to and terminates on said township line, and no overlapping of sections or surplusage of gore-like pieces can exist, as there would be if the contrary view were taken.

Now, in regard to fractional sections and quarter sections that have been rendered fractional by reason of meandered streams, lakes, or bayous, each quarter section becomes an integer of itself and subdivision lines must be run with especial reference to the exterior lines of said quarter section. And where it may be impossible because of river, lake or unapproachable barrier to run a right line on an exterior boundary of such quarter sections for the purpose of ascertaining a divisional point, a provisional base or closing line should be run, and a temporary stake set on the proper divisional line, and then such line prolonged either way, as the case may be, to the boundary limit.

Act of April 5, 1833, directed the subdivision of the public lands into quarter quarter sections, and in every case in the subdivision of a half quarter section the dividing line should run east and west, and that the line of division and the corners should be ascertained as nearly as possible in the manner prescribed in Act of Feb. 11, 1805. That in fractional sections where no opposite corresponding corner has been or can be set, any required subdivision line must be run from the proper original corner in the boundary line due E. or W., or N. or S., as may be, to the water course, Indian reservation, or other exterior boundary of said section.

Now, as regards the proper naming of the principal intervening points of a section. I am in the habit of calling the points between the section corners and the quarter posts as the W. sub. ¼ post and the E. sub. ¼ post on the N., S., or E. and W. ¼ line as the case may be; and on the E., or W., or the N. and S. ¼ line as the N. sub. ¼ post and the S. sub. ¼ post, naming also the line on which they stand or may be set.

On the subject of the division of fractional sections above referred to I have received from our worthy and ever painstaking president a very valuable article and map exhibiting the work and manner of dividing a fractional section, rendered fractional from two causes: 1st. From its being one of the north tier of sections of a township, and 2nd. From its being intersected by meandered lakes very conspicuously. The work was performed by him in the course of imparting instruction to his class in field work. I will read his notes in connection therewith and then leave it to him to further explain the operations as performed:

SECTION 4, T. 29 N., R. 8 W.

In June, 1884, I re-surveyed this section with my class in surveying from the University, as a part of their field duty in the study of this subject.

Government corners were found, or identified, at all the places lettered and marked on the plat, 9 in all, before the survey was begun. Transit lines were run. Steel tape measures were made of all lines. The section was traversed and the survey closed by means of a broken line on its west part. The angles closed well. The traverses balanced within 1.4 feet N. and S., and 0.3 foot E. and W. For these reasons the re-survey is regarded with confidence, as it was 17,913.9 feet around the piece and it had 26 sides.

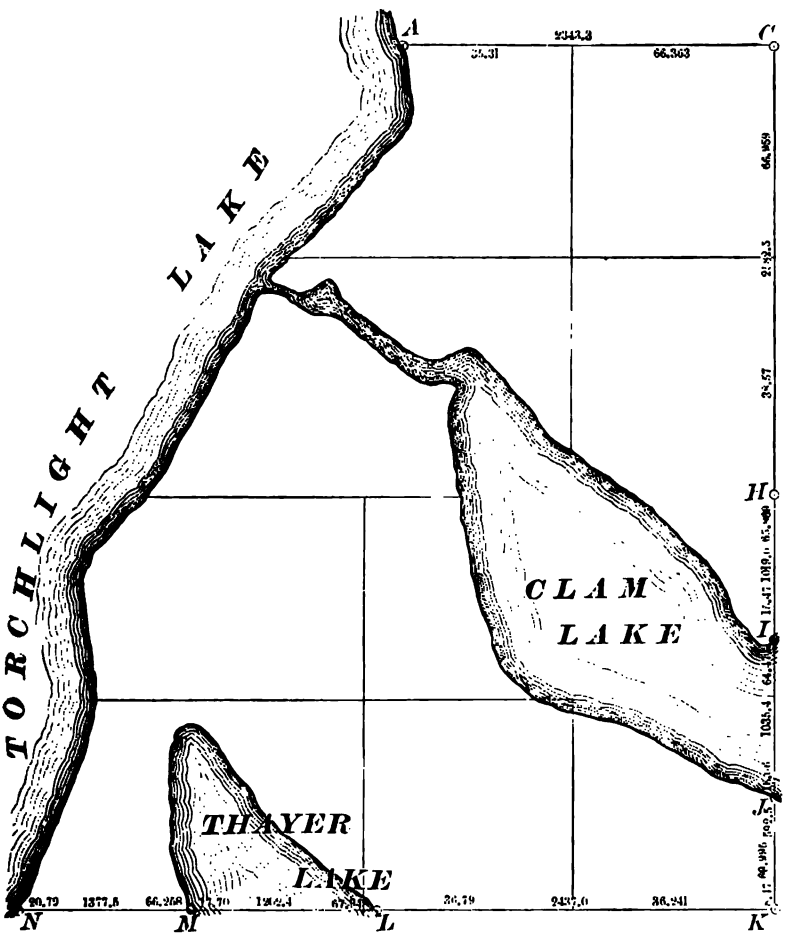
Torchlight lake, the W. boundary of the section, is 18 miles long N. and S. and 3 miles, or so, wide E. and W., thus excluding any use of the method of completing the section in conformity with those adjoining it. It had to be subdivided by itself independently. The other lakes that cut it introduce special features. The sub-division lines are those shown on the U. S. Plat. Between each pair of corners will be found entered on the plat the U. S. measure in chains; the true distance, obtained as above noted; and the value of the U. S. chain in feet for that line. The U. S. chain has eight different values between 64,471 and 69,953. None of the lines composing a boundary of this section are straight, or parallel; that is, there are no three corners that succeed each other in the same line, or parallel lines. There is a small deflection at every stake. The U. S. notes give the S. ¼ P. as in lake 40.00 chains from S. E. corner.

In subdividing, the S. ¼ P. was regarded as standing on the line L M 3.21 chains from the M. C. on E. side of Thayer lake; but these 3.21 chains are 67.948 each, while the 36.79 chains E. of the M. C. are 66.241 each. The S.—S. E. ¼ P. is set 20.00 U. S. chains of 66.241 each from S. E. corner, hence this ¼ P. is not actually halfway between the S. ¼ P. and the S. E. corner. The same remarks hold as to E.—S. E. ¼ P., it being on the line I J at half the U. S. chains between the E. ¼ P. and S. E. corner, but not at half the distance.

The N. and S. ¼ line was made parallel to a line whose direction is indicated by a line having a bearing equal to the mean of the bearings of the four separate parts of the E. boundary.

The E. and W. ¼ line was made a line having a bearing intermediate (according to distance) between the direction of the N. side and the mean direction of the S. boundary, this last being treated as the E. side was.

The N.—N. E. ¼ P. was taken at 20.00 U. S. chains from N. E. corner, and the E.—N. E. ¼ P. at 20.00 U. S. chains N. of E. ¼ P., because so indicated on U. S. Plat; but the value of the U. S. chain in each case was taken at its ascertained value for the line the measure is on.



RESURVEY OF SECTION 4, T. 29 N., R. 8 W., MICHIGAN. JUNE, 1884.

I lay down these three principles for general use as the result of this case:

1. The value of the U. S. chain must be determined by the distance between the monuments where it is to be used only.

2. The bearing of a U. S. line, when composed of more than one

side on the same section, is the average of the bearings of its parts, for purposes of subdivision.

3. The line joining two successive monuments on a section line is the section line between them.

It results from this that subdivision posts on section lines may not be at equal distances between other division points, or corners, on the same line.

Also, the bearing of one line, as the N. side of this section, may have as much weight as all the bearings of the parts of the opposite boundary of the section, in subdividing.

After the work was carried as far as this, the further subdivision of this section will proceed on the *interior* lines as usual, but on the exterior lines the distribution of distances must be conducted according to the various U. S. chains, as noted above, and this system be carefully observed, however far the subdivision may be carried.

1885, 1-7. J. B. DAVIS,
Ann Arbor, Mich.

1st. I will only add to his first proposition of conclusions—if the monuments are standing; if not, then by the mean of at least three values as obtained on other lines of the same section.

2nd. Unless the section corners and quarter posts are standing, then the bearing of the line from section corner to quarter post, or from quarter post to section corner, is to be regarded as the true bearing of the line.

3d. To be regarded, as to direction, as only governing that particular locality, if more important points are in place farther on the line.

4th. Thus the bearing of the line to the left of H C is the bearing of the line from H to C. The bearing of the N. and S. ¼ line and the intermediate lines would be the bearing of a true line running from K to H. The bearing of the sub line south of A C would be the true bearing of A C.

5th. Meander posts on section lines are to be regarded more particularly as governing the distance than as governing the direction.

I had intended saying something as to the proper and appropriate notation of all the various corners of the parts of a section into which it is divisible by the government, but am apprised by the time already consumed by this article that that subject must be left to a more convenient season, in order to devote a little time to other topics that are to be treated, or referred to, as Highways, etc. In closing this subject, let me invoke your co-operation in the suggestions contained in the following lines which I have penned:

'Tis said, "He builds too low who builds beneath the skies."
But, building low, let's build that all may thereby rise.
Rise in our aims, our hopes—our works do ever well,
That future ages may the wiser, happier dwell.

The Committee on Drainage reported through its Chairman, Mr. C. E. Hollister, as follows:

In surveying a drain in August, 1881, for J. W. Smith, drain commis-

sioner, we found the water in the wells in the local basin, all about the lower point of the marsh, so bad we could not drink it. While we were there, two children died suddenly of diphtheria which disease was carried by a boy-visitor from there to St. Johns. The village schools were closed to prevent the spread of the disease, but over forty deaths from this cause occurred before the following spring.

The main street of the village of St. Johns descends rapidly to the north. In the rear of the stores is an alley mostly devoted to privies. During heavy rains the water sweeps down through this alley, floods the privy vaults, and flows down over the surface in a disgusting, fetid stream.

In a large part of the village of Laingsburg, instead of draining the soil to the depth required for cellars, the cellar is cemented the same as a cistern to keep the water out, while water stands in the soil within one and one-half to two feet of the surface. A large part of Clinton and Shiawassee counties is flat clay land so that a drain to the cellar must run a long distance for outlet. As yet no drainage is attempted. Holes are dug under the houses for storing vegetables, etc. At the first thaw they fill up nearly to the floor timbers with water, which dries out by July or August.

Do not these facts proclaim the need of drainage and a phenomenal ignorance, or wanton disregard of human life?

The Committee on Railways and Bridges reported through its chairman, Mr. W. B. Sears, as follows:

EAST SAGINAW, MICH., February 16, 1885.

Mr. President and Members, Michigan Engineering Society:

GENTLEMEN:—Your Committee on "Railroads and Bridges" have, I am sorry to say, neglected their duty. Two of the members, Messrs. Mason and Reed, have been so fully occupied, they could give no time to the preparation of facts and statistics such as they would like to submit. Speaking for myself, I have some conception of what *should have been done*, to interest and instruct the members of our association, and through them—so far as we can influence public opinion and the actions of men—guide and direct them in proper channels to secure, with the least outlay of money, more *safety* to the traveler on our railroads, and *better methods*, as to the construction of Highway Bridges in our state.

Taking half a dozen specimens of the poorest bridges in use—some of which have been duplicated inside of fifteen years, and the second structure about ready to tumble down—getting the history, first cost, cost of repairs and renewals, and the total cost to date, including interest on the capital invested; and then comparing these items with the cost and maintenance of safe, durable and properly constructed bridges, such as enlightened public opinion calls for, and the law should demand:—this, it seems to me, is the proper course to pursue and it *must be done* before we can show a majority of tax-payers the wicked waste of the present system. Not having time to do this work well and thoroughly, I have done nothing. Unprofitable servant—cast him out! but, listen to a few

suggestions. To collect the proper data, make sketches, plans, strain sheets, estimates of cost, giving actual cost when attainable, of a sufficient number of existing faulty structures, properly tabulated and arranged with brief notes showing the essential and important facts pertaining to the same, would employ a small corps of skillful men, experts, for three months. Who knows anything about highway, corporation and city bridges; as to number, cost, average life, the number of failures annually, the causes of failure, and the loss of life and property sustained thereby in this state? Do the counties keep an intelligent record of these expensive but necessary agents, and do they report on same to some competent state officer who has the full statistics?

So far as I am informed, we have no accessible record of any value, on this important subject. Should we have it? In view of public economy and safety, in my judgment, the state should pay for this work, and the president of this society be called upon to name a committee, and act with them as a "Civil Service Board" to select experts, well trained and competent men, both in the theory and practice of bridge construction, to execute the work. We have in this country many strong, well organized, reputable firms, engaged in the construction of bridges, with an expert, trained force of skillful engineers and mechanics who know how to arrange and proportion all details so as to secure safety and durability in bridge structures; but it is patent to the least observant among intelligent men that *these firms do not construct* our Highway Bridges.

They have imitators in this work and traveling agents glib of tongue —with abundance of rhetoric and cheek—to mystify and humbug highway commissioners. Limited observation and experience prove that in a majority of cases they *succeed* in doing this, and put up cheap, unsafe structures, worth, as a matter of fact, about half the money expended.

REMARKS ON RAILROADS, ETC.

Our railroads in Michigan, particularly the leading and trunk lines, are good and well maintained, when compared with those of other states. We have a great abundance of first-rate material for ballast and good ties —everything for making and maintaining good roads, except stone for bridge abutments, piers and culverts. As new quarries are being discovered and opened up for use, and the cost of transporting stone from adjacent states reduced in price, many of the railroads can now proceed, at reasonable cost for masonry, to construct permanent foundations for all important bridges, as renewals become necessary. We Americans are noted for being *fast*, and in a new country with limited capital, wanting means of transportation, our railroads were nearly all constructed *in too much haste*, on borrowed capital, during the rushing, busy seasons, when labor and material were both high. The miserable, *poor, worthless iron rails* that were first used in our tracks - costing from $80 to $90 per ton, when it never was worth $30 per ton-- lasting from 2 to 4 years under moderate traffic, made them expensive plants to the owners and a heavy burden in tariff rates to the public. As a rule, they have all cost too much

money per mile. The alignment in many cases, to bring them to and near every small village that donated a few hundred dollars to aid in their construction, is bad, and the grades adopted in order to cheapen first cost are, in numerous cases, *outrageous* and a tax both upon the present owners and the public that neither can very well stand. The railroad companies will modify and remove these faults by degrees, but an intelligent commission in this state, to examine into and report upon the facts, might lead to important results. It would show that with some reduction in mileage, and the same motive power, many of the roads could do more work, better work and cheaper work than they now do.

By commissioner's report for 1884 we have in the state of Michigan 5,044 miles of railroad, equal to one mile for each 11¼ square miles of territory. Total cost of road and equipment, $209,880,817.15. Average cost per mile of road and equipment (about) $41,600.00. There must be, in these figures, a large share of *water* and *poor iron*. Bridges of all kinds, 1,806. Total length, 241,266 lin. feet=45$\frac{79}{100}$ miles.

Kind of Bridge.	Number.	Length in feet.	Length in miles.	Estimated cost per ft. including supports—piers.	Total cost.
Wooden,	529	58,528	11.09	@ $30.00	$1,755,840
Stone and iron,	81	10,096	2.10	" 70.00	776,720
Combination,	20	3,090	0.59	" 60.00	185,400
W'd'n trestles,	1,176	168,552	31.92	" 10.00	1,685,520
Totals,	1,806	241,266	45.70	av. price, $18.25	$4,403,480

At the above figures one mile of bridging would cost $96,360.00, and the average price would be, per lineal foot, $18.25. By an inspection of this table we have 2.69 miles of what may be termed permanent and safe bridges, and 43.01 miles of temporary wooden structures, that require constant watchfulness and care on the part of railroad employes to insure public safety; and these structures have to be renewed, a majority of them, every ten years. We get here some idea of the importance, magnitude and cost of these works—they run up into millions. What shall we say of the cost of highway, corporation and city bridges? Nobody knows; but it must be nearly double those above noted. By the laws of this state, our railroad commissioner is expected to examine and see to it that this immense line of bridges—46 miles, in 1,806 different places—is kept safe, sound and in good working order, to protect the lives of the public who glide over them by thousands daily! Can he do it? Does he do it? We believe our commissioners have all been high-minded, honorable gentlemen, who try to do their duty; but by what kind of "hocus-pocus" trick can they, as Prof. Vose says, "by riding over a railroad once or twice a year, occasionally getting out to examine the paint on the outside of the boards which conceal a truss from view, judge very correctly of the elastic limit of the iron, which they have never seen, and of which they do not even know the existence." The commissioner, without the constant aid of a trained and capable expert on bridge construction, would have *a good time* inspecting 46 miles of bridges, scattered over 5,044 miles of railway, covering a whole state. He must, and does, no doubt, rely

upon the honesty, integrity, watchfulness and care of the railroad officials—roadmasters and bridge foremen—employed throughout the state. Immunity from bad bridge disasters in this state for the past ten years speaks well for these gentlemen. Shall we continue to trust them? I say *no!* unless they are well watched. Bridges, particularly wooden ones, need frequent inspection. Managers want *dividends*, and to get them are frequently tempted to *sail too near the danger line* for public safety.

REMEDIES SUGGESTED.

It is an easy matter (says a writer in *American Engineer* for April, 1883, No. 17) to point out what is wrong in bridge work, but it is quite another affair to suggest a remedy for the evil, which shall be at the same time both efficient and practical. Prof. Vose advocates "the appointment of state engineers to examine into the strength of all proposed bridges, and to inspect at least twice a year all the existing bridges in their states."

Another suggestion is: Let the American Government request the president of the American Society of Civil Engineers to appoint a committee of three of its most competent members to draw up *general specifications* and a complete system of designing highway bridges, containing sufficient information to show how to proportion not only the main members, but also every little detail that can occur in a bridge. Then let the government constitute this system *the standard* below which no bridge shall be built, making it a punishable offence to erect any structure not coming up to the requirements; an engineer appointed by each state to see that the laws are enforced, and any bridge inferior in strength to *the standard* condemned and destroyed and the builders prosecuted. These are good suggestions, but public opinion is not quite ripe enough to move on legislators and compel the making of laws to carry them out. We do not *want*, but no doubt *must have* more *waste* and some serious disasters to life and property to arouse it to *action*.

WM. B. SEARS.

REPORT OF COMMITTEE ON MANUAL.

Prof. Carpenter reported that the executive committee had entered into an agreement with Prof. C. F. R. Bellows, of Ypsilanti, and Mr. Frank Hodgman, of Climax, regarding the completion and publication of the Manual, as follows:

That these gentlemen are to complete the Manual in the form desired by the society, and are to reimburse the society for the amount already expended. The society, on the other hand, pledges itself through its members, to take three hundred copies, and to aid in every possible way the disposal by sale of all published.

The following is an abstract of the report by the committee, which was made orally:

Mr. G. E. Steele reported as follows:

He had not known, so extensively, the importance of the work till he came to this meeting. He had a considerable amount of manuscript for Manual prepared by Mr. Love and himself, some of the valuable parts of which were extracts from legal decisions.

We do not propose to make a surveyor a lawyer, or a lawyer a surveyor, but surveyors sometimes have to be judge, jury, attorney and pretty much everything in the case, and it becomes necessary that they should have a fair knowledge of the legal requirements of their work, that they might work intelligently in cases that were liable to be dragged into court.

Mr. Hodgman said that it probably fell upon him to tell more about the Manual, as he had been the one selected to visit other societies concerning it. Mr. Steele, Mr. Love, Professor Carpenter and himself did much work in getting together material for use. Pressure of other business on the other members had thrown much of this work on him. He had endeavored to give under the following heads such subject matter as he thought necessary or advisable to include in the Manual:

First—Original Surveys:

He had included the instructions for surveys for land, town plats, highways, etc.; and extracts and decisions from the land laws.

Second—Resurveys:

He had taken up quite fully the decisions of the courts and had endeavored to give extracts from all the most important ones in the following arrangement:

1. How to construe the descriptions. That was the first thing a surveyor had to do when he began a re-survey and he had condensed the substance of the decisions in such form as to be convenient and comprehensible.

2. Decisions which relate to boundary lines, the most important ones. It was of course impracticable to refer to all the decisions, but he had gleaned out the valuable ones.

He had also included a short discussion on restoring corners which he thought would be appreciated. Also the paper by Justice Cooley, which had once been printed in our proceedings, and which he considered too valuable to be omitted from the Manual.

During his visit to the Ohio society he was allowed to address the society concerning the Manual, and was listened to very attentively; after which a committee was appointed to confer with him concerning it. The committee consisted of Mr. Bowen, of Columbus, and President J. B. Strawn, who took an entire afternoon to examine the portion of the work that he had prepared, and they expressed themselves as well pleased with it. He also attended the meeting of the Indiana State society, which allowed him to address the society, giving him the closest attention and extending to him every possible courtesy.

Professor Bellows was then requested to tell the members about his work and spoke as follows:

Mr. President and gentlemen of the society: I have felt ever since my connection with the Manual that you must be all in a condition of wonder concerning how I, an obscure surveyor, came to have anything to do with the Manual. This is the first time I have attended your meetings, and you had a reason to wonder. I am professor of mathematics in the State Normal School, having a class of young men to whom I am giving instructions in practical surveying. In addition to this, as is very common to teachers, I have been writing a series of text books, a course of mathematical study, among which is to be a work on surveying. Mr. Hodgman was well known to me, and in searching round for matter for my book I thought of him, and I told him that I was preparing a work on surveying. I felt that Mr. Hodgman had things that I wanted; the instinct proved a true one, and he and I have very profitably joined issues in the preparation of the Manual.

The contents of that portion on which I am working will be:

1. Instruments and Adjustments. I have taken up this part of the work quite fully, giving full descriptions of instruments and very thorough instructions for adjusting.

2. Concise statements of mathematical formulæ needed by surveyors.

3. Areas. Under this head I have taken up the measurement and calculation of areas and have discussed the matter quite thoroughly.

4. Land Laws and Decisions. Much of the matter under this head will be furnished by the other members of the committee. We have all done some at it and from the results we hope to be able to give a very valuable treatise.

5. Drainage surveying. It is contemplated under this head to give results of work by Professor Carpenter and other members of the society in a convenient and practical form.

6. Tables of Logarithms and Functions. I have quite far advanced that portion of the work, having some hundred and ten pages of manuscript work, and am still at it.

I wish this association to understand that, as far as my work is concerned, it is a practical treatise on surveying. We have not been able to perfect arrangements with the publishers because we have not finished the manuscript and of course can not get their terms till we can give the full size of the manuscript.

The book will be about the size of Henck's Field Book or of Gurley's Manual. It will be bound in flexible leather having a folding cover, but not a tuck. The motto of the book is, "We learn to survey only by surveying." Most of the text books have been prepared for students to learn from indoors—this one is for them to use and learn from in the field.

Mr. Steele said that the committee had considered how the two branches could be united in this work, so that it might be at once a condensed text book for students and a valuable book of reference or field book for the practicing surveyor. "We call to aid the theoretical knowledge of Professor Bellows, while Mr. Hodgman and myself claim to be practical surveyors. We shall surely endeavor to make the Manual a book thoroughly practical. We believe, however, that in making the book one

that will be used by the student and younger surveyor we do well. We believe that it is a valuable book and that it should be a useful work to be sought after by them."

President Davis asked if any difficulty had been experienced by the committee where the different members had treated on the same subjects.

The committee answered that no difficulty had been experienced, but that it was found rather to be an advantage, as one member would think of things that the other might not think of and they were able to select the best and most valuable parts of the combined efforts.

President Davis said that he possessed a complete and properly identified set of all the instructions that had been issued from the Land Office, which were at the service of the society for any use that might be desired to be made of them.

He also stated that in his complete collection of the instructions from the Land Office were many curious and interesting things. His copy was identified by a letter of transmission, and this is a valuable point, as it puts the instructions in shape to be used as evidence. On that account it would be well that such extracts from the instructions as the committee saw fit to embody in the manual be taken from his copy.

Professor Bellows said that, as a member of the publishing committee, he wished to explain that it was necessary to keep the size of the Manual within economical limits. If the work met with success he hoped that at some future time it might be much enlarged and perhaps the two branches separated and published in two separate volumes.

On motion the report was accepted and adopted.

REPORT OF COMMITTEE ON HIGHWAY BRIDGES.

The committee appointed to the consideration of legislation for highway bridges regret that limited time prevents their making so careful a report as the importance of the subject demands.

They have discussed the matter in various lights, taking into consideration the suggestions made by the president, also the feasibility of establishing a "standard of strength," as discussed in Mr. Sears' paper yesterday, with competent supervision of actual work.

We think that a measure which would meet our views as engineers would be too radical a change from the existing *modus operandi* to stand any chance of being adopted in the Legislature, and we should not wish to recommend any half-way measures.

Our suggestion then is that the Association memorialize the Legislature in a paper setting forth the loose manner in which bridge work is done at present, the false ideas of economy that are allowed to prevail, the consequent danger to which all citizens of the state are exposed, and then advocate appropriate legislation.

As to the details of such proposed legislation, we are not able to report

in so short a time, and recommend the appointment of a standing committee on Highways and Highway Bridges to take action.

We think that Michigan has been so fortunate in immunity from serious accidents that the state is not yet ripe for any decided changes, and the best we can do is to put ourselves on record as advocating more thorough supervision of work, and making the responsibility for bad work bear more heavily on towns and town officials.

WM. B. SEARS,
R. E. WILLIAMS,
GEO. E. STEELE.
Committee.

Prof. Davis moved that the report be adopted.

Mr. Steele spoke very earnestly concerning the subject of the report. Death-traps were to be found everywhere throughout the state in the shape of highway bridges. Some sort of remedy was needed and needed badly, and the remedy must come principally through legislation. This society should do all in its power to urge the matter.

Mr. Bailey spoke in favor of the report. In the township in which he resided a highway bridge was built a few years ago. The highway commissioner was an honest, well-meaning man, but he wanted to give all his neighbors a job on the bridge instead of procuring the services of skilled workmen. Not long after the bridge was built Mr. Bailey noticed that the braces did not fit well, and he pulled out three of them without assistance and laid them up where they could be seen. He refused to pay his bridge tax and defied the collection. He was threatened with suit, but up to date had not been sued and did not expect to be.

The chair called for a vote and the report was adopted.

The chairman then announced that the paper on "Maintenance of Way," by E. Treadwell, of East Saginaw, was in order.

The following special committees were appointed by the president:

To settle with treasurer—Messrs. Watkins, Bartholemew, Leavenworth.

To revise conditions for admission—Messrs. Steele, Greene and Hodgman.

To ascertain if proceedings could be published at expense of the state—Messrs. Steele, Bartholemew, Watkins.

Constitutional amendment regarding admission of new members—Messrs. Mark, Cook and S. Olmstead.

On exhibition of instruments—Messrs. Pierson, Teed, Williams.

On nomination of officers—Messrs. Sears, Hollister and F. Hodgman.

On vote of thanks to Hon. L. S. Montague—Messrs. Guild, Steele and Treadwell.

The following reports of the respective committees were adopted:

The special committee to whom was referred Sec. 1 of the Constitution, relative to membership, would report in favor of the following:

* * * * * provided that each application for membership shall be endorsed by the executive committee and be recommended by at least two members of the Society, who shall state in separate letters to the secretary their personal knowledge of the character and professional experience of

the applicant; and further, that each application shall be presented at least one month before the annual meeting, and receive at such meeting a vote by ballot of three-fourths of the members present.

Also, a by-law to stand as

SEC. 6. A list of all candidates for election as members of the society, and their endorsers, shall be posted in a conspicuous place at the opening of the annual meeting. The election of members shall take place in the afternoon of the second day, in executive session.

GEO. E. STEELE,
CHAS. E. GREENE,
F. HODGMAN.
Committee.

The committee to whom this is referred reported as follows:

Your committee, having carefully considered the within proposed amendment of Constitution and By-Laws regarding membership, would most respectfully recommend its adoption.

GEO A. MARK,
M. S. COOK,
S. OLMSTEAD.
Committee.

REPORT ON SURVEYING INSTRUMENTS.

Your committee regret that the exhibit of instruments is less complete than was anticipated, owing partly, no doubt, to the weather, which prevented exhibitors at a distance from coming, and partly to the extreme modesty of members in exhibiting the instruments they use. Wishing to show due respect to age, we will notice first a venerable compass belonging to Mr. Leavenworth, which has doubtless settled innumerable land line disputes, and made a generation of surveyors independently rich. This apparently excellent instrument was made by Meneely & Orthout, Troy, in 1836, and seems excellent in all respects. We advise all engineers, especially the younger members of the society, to take a good look at this, as compasses will soon cease to be classed and exhibited as surveying instruments and become of value as curiosities and antiquities.

Next comes the Buff & Berger transit shown by Mr. Welles. The compass in this, by the way, is excellent, and there are so many new features, peculiar to the engineer's transit, that a comparison of the instruments justifies the above remark, which was made with no intention of disrespect to the compass work that has been and is still done. We commend the general construction of this transit, and especially the form of tangent screws, vernier shades, sand shade, clamp screws etc. We mean to institute no invidious comparison between this instrument and those of other makers. It is an accidental circumstance that no other makers exhibit this year. Beckman, Young and Gurley promised to show specimens of their work, and had they done so each would have shown

points of excellence for which we should have given them credit. The Harris Drain Level reached here too late for us to examine it.

The leveling rod, or cross-section rod, exhibited by Mr. H. F. Bean, the inventor and patentee, is probably the most novel feature of the exhibit. We have not space to describe it in detail, but will say that, by an ingenious device for sliding figures representing feet, the rod can be set so as to eliminate "height of instrument"—in other words, make the horizontal cross-hair of level coincide with zero on the rod, so that elevations or depressions can be read direct, saving subtraction and attendant errors. By the use of this rod and a special tape, Mr. Bean claims that a man can set slope stakes three times as fast as with ordinary rod, and with less liability to error. Your committee especially commends this rod for cross-sectioning and setting grade stakes, and can see that for many other kinds of work it is an improvement on common rods.

The exhibit of tapes is not full. Some shown are quite ingenious. Mr. Whitley shows a convenient method of reeling up with a very ingenious handle, that obvia'es the necessity of using a reel, but we all think nothing has appeared that is, on the whole, equal to Hodgman's tapes for the class of work for which they are designed.

Mr. Geo. W. Dickinson, of Charleston, Ill., exhibits a rod for alignment, with apparatus for plumbing. A good scheme of painting the side of this flat rod makes it easy to define a vertical line extending from point of rod to top; centers can be set very closely with this rod and we commend it. The same gentleman shows some well made marking pins, a good handle for carrying them and a device for dropping them perpendicularly. This latter scheme is very ingenious, and for some work we should recommend it, but for every day practice we think life is too short to admit of our working with such apparatus, or at least that our employers would not pay for the extra time required in such refinements. Still, as engineers, we should favor anything that aims to secure better work and more uniformity of measurements.

Mr. B. F. Welles, of Marshall, exhibits some bars for measuring a test line, or base line for testing tapes and chains. They are of simple form, resembling the apparatus used for coast survey work, etc. These have been tested in the coast survey office, as shown by letters, and give results that are practically perfect. A set of these bars would be a good investment for a county, for the use of surveyors and engineers in that county.

Mr. Roe, of Patchogue, N. Y., exhibits a pantograph, or instrument for enlarging or reducing drawings, which seems to be well made and reasonable in price.

We hope another year that manufacturers of instruments will make a fuller exhibit, and that members will favor the Society by bringing with them whatever seems new and valuable in the way of instruments, rods, tapes, and other apparatus.

A. J. TEED,
GEO. S. PIERSON,
R. E. WILLIAMS.
Committee.

Mr. Steele, of the Committee appointed to confer with the Labor Bureau, reported that the committee had had an interview with the Commissioner of Labor Statistics and he had told them that it would be at least a year before the next report of the Bureau would be issued, as the present report had but recently gone to the printer and probably would not be out for a month. Therefore the printing of our proceedings with the report of the proceedings of the Bureau was impracticable and the committee would report adversely concerning doing so. However, the commissioner expressed himself as very friendly to our society and he as chairman of the committee would suggest that the Secretary be authorized to furnish the Bureau with any records or statistics of our proceedings.

Mr. Guild said that as the report of the Labor Bureau for this year would not be out for a month he thought it might be possible that our proceedings could be published with it and suggested that the committee confer with the Bureau and ascertain if this could not be done.

The President thought this a good suggestion. Professor Greene explained that though the report of the Bureau would not be out for a month perhaps, yet it was already in the hands of the printer and such a change could not consistently be made.

Mr. Steele stated further that the power granted the Labor Commissioner by the law, gave him power to embody our proceedings in his report and furthermore they would be in harmony with his work in general.

Report accepted.

WHEREAS, Hon. L. S. Montague has placed this society under great obligations by his very able paper entitled "Legal Position occupied by a Surveyor in the State of Michigan." Therefore,

Resolved, that the thanks of this society be tendered to L. S. Montague and Secretary be instructed to engross a copy of these resolutions and send them to the author.

E. F. GUILD,
GEO. STEELE,
C. E. HOLLISTER.
Committee.

LANSING, MICH., February 19, 1885.

REPORT OF TREASURER.

RECEIPTS.

Cash on hand as per report of 1884	$ 95.19
Received from dues of members	38.00
Received fees new members	79.00
Received reports sold	19.35
Received advertisements	176.00
Total receipts	$407.54

EXPENSES.

Paid to manual committee	$ 40.00
Labor, mailing and writing	11.15
Expressage on reports	8.20
Postage on reports	45.15
Publishing proceedings	195.00
Expenses of Saginaw meeting	22.00
Printing, W. S. George	3.75
Executive committee	25.90
R. R. certificates	3.00
Total expenses	$354.15
Cash on hand	$53.39

LANSING, February 20, 1885.

To the Michigan Engineering Society:

GENTLEMEN:—Your committee to whom was referred the report of the Treasurer for auditing, desire to report that they have examined his book of accounts and the vouchers connected therewith and find them correct.

JOHN J. WATKINS,
H. D. BARTHOLEMEW,
I. H. LEAVENWORTH,
Auditing Committee.

NEWLY ELECTED MEMBERS.

The following members were regularly elected during the session:

Allen, Jerome, Milan.
Appleyard, Wm. P., Lansing.
Bamber, Herbert, Highland.
Barber, Horace, Frederick, Dakota.
Bean, H. F., Leslie.
Breakenbridge, C. S., East Saginaw.
Campbell, Wm. A., East Saginaw.
Carpenter, L. G., Lansing.
Chappell, A. J., McBrides.
Childs, A., Lansing.
Clark, J. M., Howell
Cross, J. A. S., Bangor.
Dennis, E., Jackson.
Done, G. W., Pine Run.
Elliott, Wm. P., Chicago.
Fowler, Geo. L., East Saginaw.
Goodale, O. C., Chesaning.
Grant, E. W., La Junta, Colo.
Granville, J. J., East Saginaw.
Hayden, O. S., Indian River.
Holmes, J. W., Batavia, N. Y.
Howe, C. F., Ishpeming.
Jarvis, S. E., Lansing.
Luger, J., Lansing.
McLouth, L., Lansing.
McLeod, D. A., Moline.
Morley, F., Ann Arbor.
Muenescher, E. W., Grand Rapids.
Newton, E. S., East Saginaw.
Porter, Wm. M., Detroit.
Sanford, J. A., Jackson.
Shaw, Orin S., Covert, Van Buren Co.
Shaw, T. E., Shaw P. O., Presque Isle.
Smith, Jessie, Detroit.
Sturtevant, H. B., Ishpeming.
Tuthill, Job, Ionia.
Walcott, Geo. D., Jackson.
Wickes, H. D., East Saginaw.

NOTE.—The attention of members is respectfully called to the change in the Constitution respecting admission to membership. Proper blanks can be had for application to membership by addressing the Secretary, Lansing, Mich.

REPORT OF THE COMMITTEE ON NOMINATIONS.

Michigan Engineering Society: Officers for 1886:

For President—J. B. DAVIS.
For Vice President—GEO. E. STEELE.
For Secretary and Treasurer—R. C. CARPENTER.
Committee—W. B. SEARS, H. D. BARTHOLEMEW, J. J. WATKINS.

On motion the Secretary was directed to cast the vote of the Society for the above list of officers.

The standing committees were appointed by the President-elect, as given under the proper head at the opening of the Report.

NORTHWESTERN REPORTER, VOL. XX., NO. 16, PAGE 826.

COMMISSIONER OF HIGHWAYS, *vs.* BEEBE. } Pleading—Action for Negligence of Surveyor. Complainant—Demurrer. Filed October 15, 1884.

Complaint, in an action by a commissioner of highways against a surveyor employed to survey line for road, for negligence in the performance of his contract; held sufficient and demurrer overruled. Error to Schoolcraft. W. F. Riggs for Plaintiff. Geo. K. Newcomb for Defendant. Sherwood, J.

In the month of August, 1883, the commissioner of highways of the township of Thompson, in the county of Schoolcraft, laid out and established a highway on the quarter line running East and West through section 31, in said township; and as such commissioner, at the instance and request of the defendant and for certain compensation, employed him to make a survey of, locate and properly designate the said quarter line, it being the center line of the highway, to enable the plaintiff to open and improve the same. The defendant entered upon the business of making the survey, and so negligently and unskillfully performed the work that he failed to ascertain or designate said quarter line by his survey; thus rendering it necessary to make a new survey and abandon a large amount of road constructed at a large expense on the line designated by the defendant, before his mistake had been ascertained, to the great damage of the plaintiff, and to recover which he brought this action on the case. The defendant interposed a demurrer to the plaintiff's declaration, which was overruled by the circuit judge, and the defendant brings the case into this court, alleging error upon that ruling.

The demurrer was special, and the causes relied on were as follows: "(3). The said declaration and the cause of action alleged therein are double, and not single; (4) the said action is brought against said defendant as county surveyor, and yet said declaration alleges a cause of action against said defendant individually; (5) the said declaration alleges no sufficient cause of action; (6) it does not appear in and by said declaration that the plaintiff was authorized by law to lay out and establish the highway described therein; (7) it does not appear, in and by said declaration, that said plaintiff was authorized by law to let any contract for the construction of said highway."

We do not think the demurrer is well taken. There is no question made but that the plaintiff has the right to maintain the suit. The declaration avers the laying out and establishing the highway in accordance

with the statute upon the quarter line; the employment of the defendant to survey, ascertain and designate the line pursuant to the statutory requirements; that under the employment it was the defendant's duty to perform the work properly, skillfully and correctly, and that he failed and neglected so to do; and in consequence of the neglect the plaintiff was damaged, and states the items of damage; this was sufficient, and if these averments were properly sustained by proofs would entitle the plaintiff to recover. The plaintiff was not required to state the proofs in his declaration. The mention of the defendant as county surveyor was of no significance. The duty averred was that arising from the employment of the defendant and not from the office he held; but under either he would be required to do the work undertaken properly and correctly.

We think the declaration clearly apprises the defendant of the nature and extent of the claim made against him. Whether he was a professional or official surveyor, or represented himself as such, his undertaking was that he should bring to the work the necessary knowledge and skill to perform the same properly and correctly; and if he failed so to do, and the employer sustained damages in consequence of such failure, the plaintiff will be entitled to recover.

The judgment must be reversed and the demurrer overruled, with leave to defendant to plead to the declaration.

(The other justices concurred.)

AREA OF LAND.

The president read a letter regarding a method of finding the area of land, from Hosea Paul, of Cleveland, which he stated as follows: Divide by 11 twice, 6 twice and 10 once. There are 66 feet in a chain and 10 square chains in an acre.

It was moved that the letter from C. M. Brown, which recommended legislation concerning surveyors, granting especial privileges to members of the society, be referred to the committee on legislation, substituting the words "any competent surveyor," instead of "members of the Michigan Association, etc."

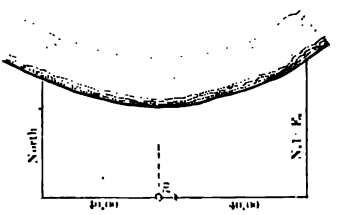
LOST CORNERS.

A discussion then followed concerning the cost of perpetuating lost corners, as provided for by law. Messrs. Shaw and Hodgman spoke of their experiences in the work; other members gave their opinions of the matter, the general conclusions of all being that the price stated in the law ($250.00 per township of 36 sections) was much less than the work could be done for.

QUESTIONS IN PRACTICE.

ANSWERED BY I. H. LEAVENWORTH, SAGINAW.

1. The south quarter post of a fractional section being 70 links west of its equidistant location between section corners, the east (fractional)



section line bearing N. 1° 00′ E., and the west line running due North, what is the correct bearing, or course, of the N. and S. ¼ line of said section? M. S. COOK, County Surveyor, Manistee.

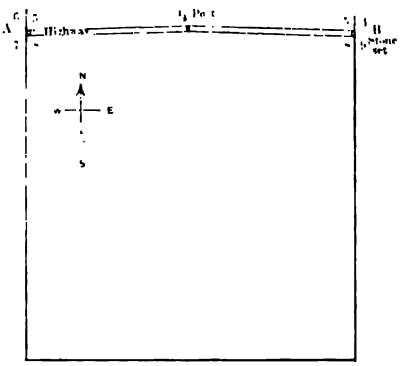
Answer.—The bearing should be such that it would intersect the north line of the section equidistant between the section corners, which in this case is 30′ E., the average of the bearings of the adjacent section lines. (Adopted.)

2. Your attention is respectfully called to the manner of re-establishing extinct interior section corners, as provided in the amended statute of 1881. You will notice that, whereas, under the old law the necessary work of re-location was by alignment of opposite points, etc., the amended law requires a re-measurement in each of the several directions. Knowing that so large a number of recorded measurements on east and west section lines, and also on closing lines of fractional sections are fictitious; knowing also the difficulty and impracticability of locating extinct corners by east and west measurements in townships whose survey is largely represented by bogus field notes, do you think further legislation regarding the subject advisable? If so, what is your opinion of the following proposed rule, and what change would you recommend, to wit: "Extinct interior section corners must be re-established at proportional distances, as recorded in the original field notes, and in a right line between known points, north and south of such extinct section corners, *provided* that in case all known points, north or south, and including either adjacent section corner or most northerly interior quarter post shall be extinct, the

said re-establishment may be made in like manner by measurement, east and west, between the respective quarter posts adjacent to the corner required." M. S. COOK, County Surveyor.

Answer.—The present law corresponds with the laws of the U. S. and must be followed. (Adopted.)

3. The quarter post on the north of section eight is lost. Northwest corner identified by witness trees. Northeast corner defined by a stone set in ground and has always been kept. A straight line joining N. W. and N. E. corners of said section eight passes about 30 links to one side of the place which all old settlers claim to be the original position of the ¼



post. All old settlers agree to the place within a circle of about 2 feet. How should the ¼ post be restored? By instrument and chain or by accepting statement of old settlers verified by measuring line? Survey bill of road intimates ¼ post found at that time, but does not give bearing of either ½ mile, nor even say a crook is found in the line. Quarter post is mid way between section corners if set where asked to place it.

A. A. FOSDICK.

Answer.—"The law, as well as common sense, must declare that a supposed boundary line long acquiesced in is better evidence of where the real line should be than any survey made after the original monuments have disappeared." Cooley. Proceedings of 1883, page 115. (Adopted.)

No. 4. What number of hours constitutes a day's work in surveying?

A. A. FOSDICK.

Answer.—That depends on the practice of surveyors in the neighborhood where the work is done. I have never made a practice of having any particular hours, but when I break into a half day to charge for a half day, and never charge for more than one day in a day, unless I use part of the night. (Adopted.)

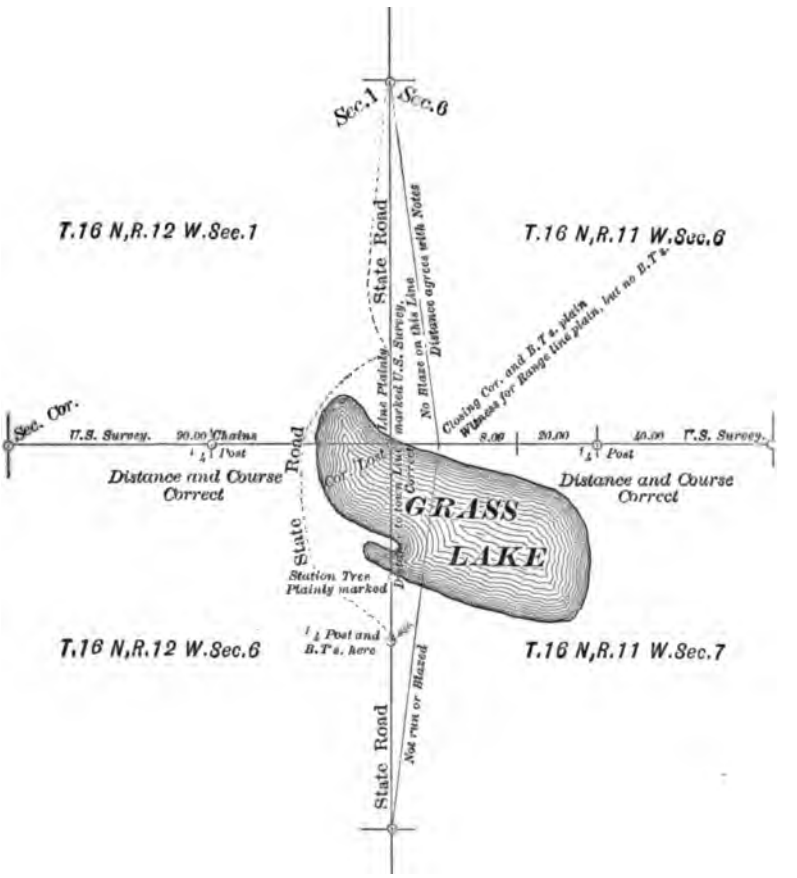
5. Do you approve of the method of subdividing section six that is given in the Minutes of the Missouri Association, 1883, page 25?

T. W. PETTEE.

Answer.—I do not. Making the jog at the quarter post on the north

the same with that of section 31, as that at the N. E. corner, and that at the west the same as the southwest corner. (Adopted.)

6. Black lines and figures correspond with map in State Land Office. Original survey made in 1837. Re-survey of interior lines made in 1856. Old corners and B T's destroyed and new ones made. Found all the corners and ¼ posts except ¼ post to 6 and 1, which is claimed to have been dug up in state road, and corner on range line in Grass Lake. Timber of quality described in notes for B. T's is there, but mostly decayed. De-



cayed timber of quality described for station trees north of lake on straight line at proper points I found. Starting from ¼ post to 7 and 12, thence north, I found distance to station tree correct. Distance to marsh, or lake, distance to and across hard point, to north side of marsh, or lake, I found all correct. Complete notes say there are no offsets at corners on town

line. Bearing trees for closing corner are a few links distant, while the same for range corner are 205 and 207, and on same side of line as those for closing corner. Distances on E. and W. line all point to the use of the closing corner, though re-survey of line between 1 and 12 claims to have used range corner. Required, the line between 1 and 6, and 7 and 12.

F. A. PALMER, McBride, Mich.

N. B. All areas are reckoned from line passing through the closing corner. F. A. P.

Answer.—The work of the surveyor on the ground takes the preference to that of the draughtsman in the office. The range line should be established where it is marked on the ground, and to correspond with the field notes, without regard to the plat, where the two do not agree. (Adopted.)

Resurveys of Old City Plats.—STREETS.—Make the streets of the standard width called for by the plats and take no account of any excess or deficiency. Throw the excesses or deficiencies upon the blocks and distribute it pro rata amongst the lots between land marks.

This will give streets of uniform width, make their lines on a true range, and secure to the public its full rights as expressed on the plat.

If the streets share the excess or deficiency the following will result: The side lines will present jogs. Streets recorded as of the same width will be of different widths. The two parts of the street on opposite sides of its indicated center line will be of different width.

ESTIMATING THE AMOUNT AND VALUE OF STANDING PINE.

By S. S. HASTINGS, St. Louis, Mich.

Surveyors are frequently called upon to *look up* and estimate descriptions of pine lands, and it is quite necessary that they should know how to do it correctly, so that parties may not suffer loss from their work; for not many of the dealers in pine lands ever make a personal examination for themselves. Sales of tracts of pine amounting to over half a million dollars have been made where the purchasing party did not see the land, but relied on the report of his expert who made the examination. The necessity of doing reliable work is very evident.

Some of the necessary qualifications a man must possess in order to do reliable work are—to be able to find to a certainty all descriptions of land he is looking after; to measure distances reasonably correct by pacing or counting his steps; to tell how many feet of lumber a tree will cut at a glance of the eye, and whether it will cut clear, common, or cull lumber. To acquire skill in pacing, count one's steps between the section corners and quarter posts, and find how many steps are required for half a mile. In the author's experience, 65 counts, counting the right foot only, will reach 20 rods, or 70 if it is very rough and brushy.

The defects of pine are learned by careful observation of tracts of pine while being cut, and of timber rejected as not worth cutting. Learn all one can, from the men cutting timber, about black knots, punk rot, etc. In estimating the amount of lumber a tree will cut, it is well to remember that a tree 26 inches in diameter at the butt, that will cut five logs, can safely be estimated at 1,000 feet, and if it is 36 inches in diameter it will cut 2,000 feet. If the tracts are some distance from settlements it will be necessary to take two assistants and a camping out-fit. One of the assistants should understand running a pocket compass, and pacing. First find the land, then retrace the section lines by re-marking and cutting away some of the brush. Thus for the W ½, S E ¼ of Sect. 10 begin at the ¼ post and retrace the section line east; at 20 rods leave a mark on a tree; at 60 rods also mark a tree, generally with chalk. Draw in a note book a diagram of the 80 acres, on a scale of 10 chains to an inch. Now direct the man with the pocket compass to proceed due north, counting his steps, and to stop at 20 rods. Follow on and count all the trees that are judged worth cutting for lumber for four rods to the right and left of the line of travel. At 20 rods stop and enter on the diagram all streams and swamps that may have been crossed. Proceed in the same manner 80 rods, to the north line of the 40 and make a record, to keep the estimate of each 40 separate

pose there were counted in the strip, 8 rods wide and 80 long, 120 trees, which would be an average of 30 trees to an acre; as this strip is in the center of the east half of the 40, it may be called an average of the 20 acres, therefore on this 20 there would be 600 trees, which, if estimated to cut 800 feet to a tree, would make 480,000 on the 20 acres. It is very necessary to observe whether the strip one is counting is a fair average of the land for 20 rods each side. If one sees 3 or 4 acres of the 20 outside of the strip counted that had little or no pine on it, deduct what is thought sufficient; and if there is a thick group of an acre or more in extent outside of the strip, observe it carefully in passing and then add to the sum total the amount this group exceeds the average. Divide the timber into four classes, viz.: Uppers, good common, coarse common, and culls, or small. Now proceed north to the next 40, 60 rods; then turn west 20 rods, stop and make an entry of the timber as found. Then proceed on west 20 rods, then south 60 rods, which completes the north 40. Make an entry of all other varieties of valuable timber; then proceed south across the first forty to the section line, which should be intersected at or near the marked tree. Now complete the record of this 40.

If there were found on the W. ½ of this 40, 320 trees of fair size, averaging 1,000 feet to a tree, with the E. ½ there would be 800,000 on this 40, which may be classed as follows: 50,000 uppers, 200,000 good common, 400,000 coarse common, 150,000 culls, or small.

The *value* of standing pine depends largely on its distance from floating streams. If it is within two or three miles of such streams, or where it can be easily reached by logging railroad, the timber may safely be estimated as follows: Uppers, $12 to $15 per thousand; good common, $8 per thousand; coarse common, $3 per thousand; culls and small, $1 per thousand. This would make the pine worth on this 40, $3,550; to which may be added $50 for oak and $100 for farming purposes; total, $3,700.

It is difficult to describe the different classes of pine intelligibly, without having the timber before one.

The *Uppers* include those large trees that have arrived at full maturity, with long bodies, free from knots, and found mostly growing among hardwood timber, generally but 3 or 4 trees to an acre, and from 3 to 6 feet in diameter. The lumber is soft and free from pitch.

In the class *Good Common* is included timber that is sound, thrifty, and with 39 or 40 feet of body free from visible knots.

Coarse Common includes timber that has small limbs and sound knots nearly the whole length of the tree, and where timber stands thick from 25,000 to 40,000 to the acre a large portion of it is apt to be coarse common.

Culls and Small includes that class of diseased and sickly pine that shows black and pitchy knots, punk rot, etc., and yet is worth cutting, as they will generally produce two or three fair logs, that are more profitable to work into shingles than lumber. We also include in this class the small pine from 10 to 14 inches in diameter; also the scattering Norway.

After going over each description in this manner, we are able to furnish a safe estimate of its value. Do not abandon a piece because it is

swampy and you cannot see any pine from the section line. We are very apt to be decided in the size of a swamp. They look much larger than they are. A swamp of 10 acres will often look as if it covered the whole 40, therefore examine every description thoroughly. Have no guess work. We often find valuable clumps of pine on islands in swamps, hid among cedar and hemlock.

Where pine stands scattering, not over 100,000 to a 40, it would be better to count every tree.

Make a map of the land, showing the streams, swamps, lakes, roads, settlements, etc.

DISCUSSION.

MR. GEO. E. STEELE:—Once in an important case he had measured the upper and lower diameters and length of every pine tree cut on two hundred acres of land. From these measurements he made tables showing the taper of the trees. Afterwards on other work he, with an assistant, measured with calipers the upper diameter, also the length, of every tree, setting down the results in a fractional form—the upper diameter as numerator and the length as denominator. Did not generally count or estimate the number of trees, but measured every tree on a piece. He had, however, sometimes estimated by measuring the trees on what seemed to be a fair average specimen of the tract, and taking the balance proportionally.

A company published, a few years ago, a book giving very full descriptions of the pine on their lands—so full that the reader would be inclined to think that every tree had been carefully and minutely examined. This book they circulated very extensively, especially in the East, as an advertising medium to induce buyers to come to their sale of lands; and many came, but those who bought generally found themselves very badly scorched. He estimated the timber on one tract and found seventy-two million where the company represented two hundred million to be.

MR. D. SKEELS:—A common practice in estimating is to add two inches per sixteen feet to the upper diameter, or subtract the same from lower diameter for the taper, and this gave a very good estimate according to his experience. Every man has his own way of estimating pine, and every firm who employs him has a way of their own and always want him to estimate by their method.

PRESIDENT DAVIS had once estimated a large amount of white-wood, and the taper of a large white-wood was almost invariably one inch in twelve feet.

MR. S. N. BEDEN inquired concerning the methods of computing the amount of lumber that could be sawed when the sizes of the timber were known, citing a case where the method used by the lumber company gave results considerably too small.

MR. G. E. STEELE:—Lumbermen generally agree in advance on what rule shall be used—whether Doyle or Scribner. Both tables give too small results if the logs are properly sawed. Doyle's rules are much used in the

northern part of the state; a modified edition of Scribner is also considerably used.

MR. D. SKEELS:—Scribner is becoming quite generally used, as Doyle is severe on small timber.

MR. J. J. WATKINS had had some experience in estimating pine in a large case, involving about seven million feet of timber, some of which had been burned over. He surveyed all the separate pieces of pine on the tract, meandering the bounding lines of each piece of timber and of the burned district, calculating the actual acreage of the live timber and of the burned timber also; then estimated the amount of timber on a small piece that would be an average sample of the whole, and took the balance in proportion. Five persons estimated this tract of pine and only varied fifty thousand feet between the highest and the lowest. The old Doyle and Scribner books were made when the mills used the old slash saw, which took much larger slab than the modern saw.

A new edition of Scribner, using Doyle's tables in many parts, is to be issued.

THE SEPARATE SYSTEM OF SEWERAGE.

BY G. S. PIERSON, KALAMAZOO.

It is essential, as a sanitary measure, that all excretal matter and offensive household and industrial wastes be removed from the vicinity of dwellings. It is desirable that this removal be accomplished as thoroughly and immediately as possible, and in such a manner as to give the least possible evidence of its presence. Practically, these results are best attained by receiving and removing them in a deodorizing medium. It is almost universally conceded that removal by water carriage more nearly meets these requirements than any other system yet devised, being, as at present applied by our best engineers, at once immediate, complete, inoffensive and, so to speak, automatic; not depending upon the manual labor and the care or want of care of the average servant, it is readily applied and cheaply maintained.

One of the first requisites of healthy living is an abundant supply and liberal use of water. The direct mission of this water is to be polluted; being polluted it must be removed, and impervious pipes or sewers are at once suggested as the true means for its removal. Unless these conduits be impervious, (and too often they are not, as is proved by the largely augmented discharge from districts in which they are laid below the higher levels of subsoil water) they are, to the extent of their permeability, simply distributing pipes, their contents polluting the soil along their entire length. Such pollution has been repeatedly and unmistakably traced by the chemical analysis of water drawn from neighboring wells.

Sewers, from the nature of their use, must be in some degree foul. Convenience requires them to be connected with the interior of buildings, and herein lies the difficulty of the problem,—to so construct and operate the plant as to secure the maximum of cleanliness within the sewers themselves, and to completely bar our dwellings against the entrance of their contained air.

Sub-surface conduits are also required in some cases for the removal of storm water from streets, roofs and paved areas. This is especially necessary in thickly populated sections, where, by reason of unfavorable topography and the comparatively large areas of roof and pavement, and consequently impervious surface, storm water accumulates in such volume as to make its removal in the street gutters impracticable.

The removal of household wastes is the prime object of sanitary drainage. It is a function to be performed daily, hourly and continuously, alike in times of drought and times of flood, through all variations in temperature and regardless of fluctuations in sub-soil water. We

should, therefore, not allow the attainment of any object of secondary importance to prejudice its perfect realization.

It is fair to assume that if we bend our energies toward devising a system of sewers for the accomplishment of the single purpose of house drainage, making only such combinations as are favorable, that purpose will be better served, than when pursued with a less single aim. Local conditions and considerations of economy may in some cases make it the part of wisdom to combine storm water and house wastes in the same conduits for removal, but the attainment of perfect house drainage cannot be furthered by so doing, and quite likely will be jeopardized. Nothing interfering with the utmost attainable perfection in the sanitary condition of the drains connected with the interior of our dwellings should be allowed. If sub-surface conduits for other purposes than house drainage, and not so connected, are less perfect in their sanitary condition, (and from the inconstant nature of their use they must be) it is a matter of less importance; since opening into an unconfined and widely circulating atmosphere, any noxious gases are in much greater degree diluted and rendered innocuous.

It is obvious that designing a plant to meet the demands of so inconstant and widely varying a use, as the removal of storm water, presents especial difficulties, both as to economy and efficiency, and that, generally speaking, the possibilities of economical construction and service are measured by the regularity of the work. The aggregate discharge of house wastes from areas fairly well built up is in excess of the entire volume of storm water that ordinarily reaches the street catch basins. Yet the capacity required for the ample service of house drainage is, approximately, but one-fortieth of that required for, or more properly of that usually given to, sewers for the removal of sewage in combination with storm water. This ratio is based upon a study of reports of the gauging of sewers made for the express purpose of determining it, and published in the report of the National Board of Health for 1880. In fact, though representing ultimately the greater amount of work in the combined system of sewers, it is considered unnecessary to make it a factor in computations determining their sizes. In some cases it is, to a certain extent, true as argued that these large conduits for the removal of storm water are a necessity, and that, therefore, we can utilize them for purposes of house drainage free of cost in a measure. It is also true that, in very many instances where no sub-surface removal of storm water whatever is required and is, in fact, detrimental, the expensive combined system has been tardily extended, at heavy cost to abutting property, to meet the requirements of house drainage, and preserve the soil from utter pollution, where the separate system as now constructed would have better met the requirements at a much smaller cost.

The sewerage of every city presents problems for solution essentially peculiar to itself, and these must be carefully considered. Storm water falling over large areas without natural drainage channels cannot be disregarded. In many cases it may be removed with great advantage in special and short conduits, serving no other purpose, discharging at the

nearest water course, where the discharge of sewage would be inadmissible, and consequently admitting of shallow trenching and comparatively cheap construction. That its introduction as a flushing agent in sewers specially designed for house drainage will not meet the requirement is obvious from the fact that the supply is entirely beyond our control, and at periods when most needed may be withheld for weeks together.

The amount of water required for proper automatic flushing is much smaller than popularly supposed. A properly designed system for a city of 10,000 inhabitants ordinarily requires from twenty to fifty flush tanks, each of a capacity of about 150 gallons, discharging daily, or at most twice a day. The maximum amount of water required is about 2 per cent. of the water supply.

In the development of house drainage the open ditch has been succeeded by the rude, covered, but not impervious drain, intended for the removal of excessive ground or storm water, and receiving house wastes merely by sufferance, to be succeeded in turn by sewers approximately impervious and better adapted to receive offensive matter, and these, latterly in some English towns, by sewers of smaller size, constructed principally for the removal of house wastes, and admitting only such storm water as came from roofs and paved yards, deemed essential to secure an occasional cleansing of the sewers. This flushing was supplemented, in some cases, by opening gates in the water mains at the heads of these sewers in times of drouth. In fact, as late as 1815, it was a penal offense to empty house drainage into the London sewers, and shortly after, this method of disposal was made compulsory.

Next in the order of development comes the distinctly American Separate System, dealing solely with house wastes. The most notable example is the Memphis system of sewers, designed and constructed by Col. Geo. E. Waring, who had previously applied the same principles to the sewerage of several small villages.

The Separate System of Sewerage consists of impervious pipes adapted to the discharge of house wastes only, a duty comparatively uniform and constant. They are ordinarily constructed of vitrified, glazed, earthenware pipes, their interior surface well adapted to resist fouling and erosion, and offering the least possible frictional resistance to the flow of sewage. They are provided at all dead ends with flushing tanks, which are supplied by a very small, though constant stream from the water mains, and which discharge their contents automatically, as frequently as may be desired. This regular and automatic flushing is peculiar to the separate system, and the diminished size of the pipes renders it very effective, sweeping down all deposits and stranded matter from the remotest portion of the system into the mains, and the aggregate of these discharges in the mains from tanks differently timed sweeping it on to the outlet. The more regular flow and consequent immunity from variations in air space and pressure reduce the danger of forcing traps, and the smaller air space increases the efficiency of all openings in relieving any pressure resulting from such variations, and as ventilators.

Portions of the crown above the flow line and exposed to conditions favorable to decomposition and the growth of animal organisms are reduced in extent, and compared to the more porous and rougher interior surface of brick sewers, are less likely to become permanently fouled and to pollute air introduced for purposes of ventilation.

Experience has proved that there is little danger of obstruction when the sewers are properly constructed. The total cost of removing obstructions in Memphis has been about one-fourth of one per cent. per annum on the cost of construction. Capitalized at 6 per cent. per annum, this amount represents approximately 4 per cent. of the cost of construction. In other words, the interest on 4 per cent. of the cost of the Memphis sewers invested at 6 per cent. per annum would have paid all costs of the removal of obstructions and cleaning of the sewers. The cost in Kalamazoo has been much less. In fact, the main sewers at Kalamazoo have never been cleaned at all, except by the action of the flush tanks, and are now free from deposit. The water supply, however, is in striking contrast to the water supply of Memphis, being free from suspended matter. It has never been necessary in Kalamazoo to excavate for the removal of any obstruction in a main or lateral sewer, with the single exception of a case during the past season, where, in grading an alley, the top of a lamp hole was ploughed off and a portion of the masonry fell in the sewer. The Kalamazoo system has been in operation since the summer of 1881, the year succeeding the introduction of the same system in Memphis.

The superiority of glazed earthenware pipes in respect to cleanliness and capacity and velocity of discharge has been repeatedly demonstrated by practical tests. A single example will suffice. The following figures are from a report of gaugings taken in the Milwaukee sewers by A. H. Scott, Esq., civil engineer, of the City Engineer's Office, to Geo. F. Waring, Jr., for the National Board of Health. Diameter of sewer, 42 inches; grade, 1 in 400; tributary area, 70 acres; tributary population, 3,177. "The greatest flow in the main sewer on "washing day"—the greatest flow of the week—attained a depth of six inches, the diameter of the sewer being 42 inches. The channel being reduced to a diameter of 10 inches, the greatest depth of flow was 4½ inches. Reduced to a diameter of 8 inches, it remained the same, 4½ inches. Reduced to a diameter of 6 inches, it reached a depth of 5½ inches.

"The influence on the velocity of the stream by increasing its hydraulic mean depth is illustrated by the following figures: 42 inch sewer, 6 inches deep; cross section of stream, 121.3 square inches.

Ten-inch sewer 4½ inches deep; cross-section of stream, 33.1 square inches.

Eight-inch sewer, 4½ inches deep; cross-section of stream, 27.7 square inches.

Six-inch sewer, 5½ inches deep; cross section of stream, 27.14 square inches."

A study of these gaugings reveals the following facts: A vitrified pipe, having a cross-sectional area 1-5th that of the 42-inch sewer which was proportioned to the removal of storm water, removed the domestic and

manufacturing wastes at their maximum flow. The relative velocities, and consequently the transporting powers, being inversely as the sectional areas of the streams, were as 1 to 4½ in favor of the vitrified pipe laid at the same grade.

CONSTRUCTION.

Pipes.—In construction, it is essential that all pipes be laid truly to line and grade, with bells and spigots concentric. Before breaking ground an offset line should be carefully run, to which the alignment may be referred, and grades figured for stations of 12½ or 25 feet. As the work progresses, the alignment is transferred by the assistant to pegs in the bottom of the trench, set to grade by means of a self-reading rod, read directly from the level. No setting of grade pegs by measurement of cuts from stakes on the bank should be allowed.

Grades.—Gravity is the moving power. The rate of inclination determines its application to the work in hand, and is a factor affecting the completeness and velocity of discharge. Flat grades are therefore objectionable. Nevertheless, experience has shown that, with proper flushing, glazed earthenware pipes will do good service when laid at a low grade.

Man Holes.—Contrary to the usual custom, the Memphis sewers were originally constructed without manholes. Since then there have been added, according to the report of the City Engineer, Niles Meriwether, 43 man-holes and 342 observation openings. This would seem to indicate their usefulness. To a certain extent, they interrupt the regularity of the flow and decrease the carrying capacity of the pipes, and consequently should not be placed at too frequent intervals. They are rarely required in the Separate System except at the junction of two or more sewers. They are practically of little use in locating obstructions at intermediate points, as often argued, though facilitating their removal. Obstructions are best located by observing the condition of house sewers, or by observation openings or *lamp-holes* consisting simply of a "T" branch laid in the sewer at intervals, and pipe brought vertically to the surface, and capped by an iron cover.

Flush tanks are an important aid in preserving the cleanliness of the sewers. When the sewage does not accumulate in sufficient depth to effectually transport the solid matters, the sudden discharge into the head of the sewer of a volume of water sufficient to fill them nearly to their crowns, though acting but momentarily, effectively cleans them of all deposits. This momentary discharge does not sensibly occupy the capacity of the main sewers further down the line, being, as before stated, but a very small percentage of the ultimate discharge. An equally efficient flushing by a constant stream, applied directly and without the intervention of a flush tank, would require an amount of water materially encroaching upon the capacity of the main sewers, and would be inadmissible under ordinary conditions of water supply on the score of

economy. Flush tanks are ordinarily constructed of about 125 gallons capacity, and adjusted to discharge automatically once or twice in each twenty-four hours. Their capacity of discharge should equal that of the pipe into which they empty.

Lateral and house sewers should connect with the mains above their horizontal diameters, so that their outlets shall be above the ordinary flow of sewage, permitting a continuous passage of air currents in either direction, and insuring a free outlet, thus reducing the liability of obstruction and deposits at those points where they are most likely to occur. Changes in direction should be made with special curved pipe.

Ventilation.—The entire system, including mains, laterals, house-drains and soil pipes should be so constructed as to induce a free circulation of air throughout. This is best secured by extending the main house drain above the roof, unobstructed by any trap, as a ventilating pipe, and trapping each fixture independently. This ventilating pipe may be extended through the house and the soil pipe be laid into its foot through a trap, on the house side of which is an air inlet supplying air for the upward ventilating current. In the latter case the soil pipe also should be extended above the roof. The first of these methods is the cheaper, and where universally adopted, and where the plumbing is under proper supervision, has been found entirely satisfactory. It is the method adopted at Memphis, Kalamazoo, Norfolk, Keene and elsewhere. It is open to the objection that soil pipes are open to the passage of sewer air in considerable volume, and any imperfect joints or material in plumbing may admit of its escape into buildings in greater degree than where the ventilating current is fed more directly from the normal atmosphere. As a matter of fact, owing to the action of the flush tanks and sure cleansing flow, the laterals and mains are more free from foul odors than the house drains themselves. The aggregate of these openings, where universally adopted, is so ample as compared with the contained air to be purified that no apprehension need be felt from this fact.

Interior plumbing fixtures should be as few in number as is consistent with convenience. Fixtures rarely used are more liable to be used in an unsanitary condition than those used frequently and regularly, and every increase in number increases the fouled surface exposed to the confined air of apartments. They should be simple in construction, of the best material, and not encased as is the usual custom, but the piping and fixtures left exposed. Thus will be insured a greater cleanliness, better work by the plumbers and a continual knowledge of their condition. Traps should be placed as close as possible to fixtures, thus reducing the exposed foul surface of soil and waste pipes to a minimum. They should be so ventilated or connected with the normal atmosphere as to relieve any variations in air pressure induced in the pipes below them by the discharge of other fixtures connected with the same soil or waste pipe.

Cost.—The comparative cost of the Separate System, as given by

Eliot C. Clarke, C. E., Principal Assistant Engineer in charge of the improved sewerage of Boston, is 40 per cent., based upon an estimated cost of $1.30 per foot. This estimate was made in 1881. Improved methods of construction adopted since that time, which was practically the date of the introduction of this system, have no doubt been in its favor, and at present this figure probably represents too high a cost against it. The total cost of the Memphis sewers to date is approximately $1.30 per foot. The total cost of the system at Kalamazoo to date is $1.18 per foot, including a large percentage of main sewers, in some of which the trenching was peculiarly difficult. The total cost of 6 and 8 inch lateral sewers in Kalamazoo the past season, in which the trenching averaged 9 feet deep in more favorable soil, was 60 cents per foot.

Schenectady, N. Y., is at present building a complete system, entirely covering the densely built portion of the city. The work is being done entirely under contract. The average of 15 bids submitted, including manholes, flush tanks, etc., and based on estimated quantities, is seventy-two cents per foot, and the lowest 42½. The contract price on the same basis is equal to 48 cents per foot. There should be added a slight cost for increased depth of trenching, and proper protection of the outlet, and the cost of engineering and expenses of the Sewer Commission. With a greater part of the work now done, present indications are that the total of all expenditures from the agitation of the sewer question to the completion of the system will not exceed 75 cents per foot. These sewers are laid almost wholly in paved streets, and the conditions do not materially differ from those ordinarily found in work of this class.

With good management on the part of the contractor, sewers of vitrified pipe of small diameter, laid in trenches of the depth usually necessary, can be laid much more rapidly than sewers of larger diameter, the rate of progress being limited in either case by the work of one gang of pipe layers or brick layers. Rapid and carefully systematized work by the constructing engineer is required, who should take personal charge, as the decisions constantly needed in its progress, the locating and recording of junctions and similar work can not be left to an inspector. A sufficient number of junctions should be inserted to meet all future demands. Connections by cutting into the pipes where no junctions are placed can be made with about the same facility as if the pipes were of plate glass, and if so made will ruin the sewers. A perfect record of everything pertaining to the work should be made for future reference.

In the few years that have elapsed since the application of this system, it has attracted the attention of eminent engineers in the United States and elsewhere, and has been applied to the sewerage of many American cities with entire success. It has been favorably considered in England and on the Continent. It has been on trial in Paris, and has now a prospect of being considerably extended there. Its introduction marks an important era in the development of sanitary drainage, recognizing, as no other system has, the prime importance of an early removal of household and industrial wastes, which are the main factors in soil

pollution. That it will best meet the requirements of all large and densely populated cities (economy considered), is not probable. That, under competent advice, it can meet the requirements of *house drainage* more perfectly in *any city* than the combined system can not be denied. It is peculiarly adapted to many of the numerous smaller cities, which have been practically debarred from sewerage by its cost, and to outlying portions of larger ones, its comparatively small cost permitting an early and general extension, and the removal of domestic wastes before the soil has become saturated with them beyond a reasonable hope of purification.

DISCUSSION.

MR. BARTHOLEMEW gave a description of the sewerage of the Capitol building substantially as follows:

The system adopted for the Capitol and its square was the combined. The demands upon it were day sewage for five hundred full grown persons and the drainage of 11¼ acres of land. The outlet was a brick circle two feet in diameter. The city adopted a modified separate system. From the Capitol 75 rods east, by an 18-inch tile, thence north one mile by egg-shaped brick conduit, 1′ 10″ × 2′ 9″, enlarged to 2′ × 3′. In connection with sewer were storm drains for subsoil drainage and rainfall. The catch basins at the corners of the streets have two outlets, the lower and smaller into the sewer, as the first rainfall is classed as sewage, the upper and larger into the storm drains discharging into the pond. The sewer discharges below the dam. The city provided for rainfall and drainage for 320 acres west of Capitol and sewage for 25,000 inhabitants.

PURE WATER AND PURE AIR—THEIR RELATION TO THE HEALTH AND PROSPERITY OF THE HUMAN FAMILY.

By W. R. COATS, Kalamazoo, Mich.

Comparatively few people properly appreciate the vital importance of these questions, and their bearings upon our physical, mental and moral well being.

Vastly more depends upon the quality of the water we drink and the air we breathe than most people dream of. To this cause may be traced almost the sum total of all the diseases which afflict the human race. This being true, it at once becomes apparent how important it is that we should carefully study all that pertains to these elements.

In speaking of water, I do not use the term "pure" in its most radical sense. I do not mean that it should be absolutely pure, containing nothing but its simple constituent elements—oxygen and hydrogen—but pure in the sense of being free from all matter injurious to the human organism.

That nature has prepared these elements in the highest degree fitted for our use must be patent to all who will intelligently examine. To hold any other view would be to question the perfectness of the Creator's plan of the Universe, and of His laws for the care and government of the human race. Nothing in the whole range of animate nature can exist without both air and water, and it would be tantamount to blasphemy to charge that the Creator had given to His creatures these necessary elements of life in a poisoned condition. Yet it is undeniably true that one-half the water we drink and one-half the air we breathe *is* poisoned before it enters our system; poisoned by our plain disregard and disobedience of natural laws, and to this, I repeat, may be ascribed nearly all the diseases which afflict us.

Nature provides with a bountiful hand all that is necessary for the use of her creatures, but she does not place all these blessings so lavishly before us that we may partake of all things indiscriminately, and without strict observance of the laws attending the bequest. Half the texts of the Bible have for their object the enforcement of this doctrine; the old Mosaic laws were founded upon it, and the human family have suffered, not only to the "tenth generation," but to the *hundredth generation*, in consequence of their sins of disobedience of God's sanitary laws. It seems to be a world-wide custom to say, "free as water, free as air;" but it does not follow that because these elements are everywhere prevalent and everywhere free, that they are everywhere and in every condition fitted for our best use; in very many cases, the direct opposite is true, and both the water we drink and the air we breathe, instead of being the life-giving

stimulants intended by nature, have become the insidious agents of disease and death. This is not the fault of an all-wise Providence; it is entirely due to our blind ignorance or wilful disobedience of His laws.

If we will make proper use of the reasoning powers with which the Creator has endowed us, to study and analyze His laws, we shall be enabled to partake of His bounties without partaking of forbidden fruit. While all things bestowed by Providence are in their proper place good, it is essential that we should know, before making use of these things, the place, relation and form in which they are good for our use. That which is an unalloyed blessing in the form intended by nature, may prove a dire curse used in any other form.

The waters falling from the clouds in the form of rain are popularly supposed to be pure, but this is far from being correct; but even if pure, such waters would not be in the best form for potable uses. We must look to the rainfall as the prime source of all our water supplies; but before the waters of the rainfall assume the best form for potable uses, they must undergo certain other natural processes. Good and healthful water for potable uses should contain carbonate of lime to a certain degree, and to acquire this these waters must percolate the strata of mother earth after falling from the clouds.

Water falling from the clouds in the form of rain is liable to very serious contamination before it reaches the earth, by its absorption of poisonous gases and disease germs floating in the atmosphere through which it passes, and if we drink these waters in this condition, serious consequences are liable to follow.

Before the waters of the rainfall are made use of for potable purposes, they should be allowed to percolate to a proper depth in the strata of mother earth, and in the proper manner sought for there. This natural process of filtration is far superor to anything known to art, not only in removing all the harmful properties existing in these waters as they fall from the clouds, but also in giving them such other properties as are required to make them in the highest degree fit for potable uses. If we will allow these waters to sink into the earth's strata to the proper depth, and in the proper manner seek them there, we will always find water of the best quality for our use. In percolating downwards through the various strata, these waters are freed from all organic matter and given certain other needed properties. It is true that at the surface of the earth these waters are liable to a more serious contamination than in their passage through the atmosphere, but all these organic impurities are arrested before penetrating to any great depth, and all that is necessary in order to avoid the bad water and obtain that which is good is to sink our wells in proper manner below the level to which this organic matter reaches. Care must be taken, however, not to penetrate too deeply, lest in the deep, still waters below we find a more objectionable contamination from mineral matter than exists nearer the surface from organic matter.

If we would here adopt the golden mean, it would, as in most other cases, prove vastly the better way; but in this, as in most other cases, we run to extremes. We either make our drinking-water wells shallow—only

sinking just deep enough to afford the needed amount of water, and, thus leaving them exposed to all manner of contamination, drink disease and death from the drainage of our privy vaults, cess-pools, etc.—or we rush to the other extreme, and penetrate the rock strata a hundred, or perhaps a thousand feet, and obtain a water free from organic matter, it is true, for that has been extracted hundreds of feet above, but containing so much mineral matter as to poison and kill us in another manner. To illustrate this point, and as confirmation of the correctness of this theory, I perhaps cannot do better than to here give an outline of my experience in this city —Lansing—since our last annual meeting. Last winter I was employed to make an investigation relative to the development of a public water supply for this city. Before coming here I had formed the impression that it would be difficult to obtain an adequate water supply from any other source than the river. A casual examination, however, of the topographical conditions at once convinced me to the contrary. It was clearly apparent that a favorable water-bearing stratum existed at no great depth from the surface, and that the percentage of the waters of the rainfall that was received and disposed of by this stratum was amply adequate to supply all demands. A great majority of the wells of the city I found to be shallow; receiving their waters from a shallow quicksand stratum near the surface. The waters of these wells—as is usual in such cases everywhere—was bad. A few of the wells were carried into the rock strata, some of them to the depth of several hundred feet. Between these two extremes, immediately overlying the rock formation, I found an excellent gravel stratum, yielding water with greater freedom than I have ever before known, or than is anywhere recorded, and the quality of this water, to use the language of Professor Kedzie, who analyzed it, is the best I have ever found in Michigan.

I cannot, perhaps, do better than to quote directly from my report made to the City Council on March 10th last, as follows:

"It is found that nature gives us the best water through the lower drift deposit, lying between the immediate surface drift and the waters of the deep strata. I have confined my investigations chiefly to this source, to ascertain if it is feasible to obtain an adequate supply of water from it to meet your requirements, and I am glad to be able to assure you that the result of the investigation has settled beyond a possible doubt that an ample supply of most excellent water may be easily obtained from this source. Some remarkable developments have come to light during this investigation. It is found that your city is situated in a basin; that at a radius of four miles the rim of this basin is greatly elevated above its center, except where the river breaks through. The area of water shed of this basin is in excess of fifty square miles, the rainfall upon which is in excess of thirty-six billions of gallons annually, one per cent. of which is more than one million gallons per day. I have caused borings to be made to ascertain the exact strata conditions from the surface of the ground to the rock. The point selected is near the Lansing Iron Works, on the south side of Shiawassee street. The east side of the river was chosen because of the greater extent and more favorable conditions of the tributary water

shed, and because of its superior railroad facilities, which are of value in providing supplies for our pumping station. The immediate point in question was selected because of its commanding position with reference to the entire distributive system, as mapped out on the tracing accompanying this report. An iron tube two and one-half inches in diameter was sunk from the surface to the gravel stratum. The strata conditions were as follows: First, six feet six inches—made ground and muck. Second, seven feet six inches—blue clay. Third, three feet—quicksand. Fourth, two feet—clayey hard pan. Fifth, blank feet of clear, coarse, washed gravel. When the gravel stratum was reached with the tube, the water issued from it in full volume, and with such force as to bring to the surface large quantities of gravel, some of the stones being as large as could pass through the tube. Upon the tube being lengthened, it was found that the water would rise to the height of twenty feet above the natural level of the river, and the discharge at ten feet above the level of the river was in excess of three hundred gallons per minute. This surpasses anything on record. I have had samples of this water analyzed by Professor Kedzie, and also samples from one of the least exposed of the private wells located in the quicksand stratum, and also samples from the rock wells of various depths. All are tubular wells, and are supplied directly from the strata in which the lower ends of the tubes terminate; each analysis is therefore a fair showing of the quality and relative merits of the water it represents. I do not hesitate to pronounce the water of this test-well—all things considered—the best water supplied to any public service in this state. It surpasses even the Kalamazoo public water supply. While I was fully prepared for and expected a better showing for the waters of the gravel stratum than for the waters of any of the other strata, yet I did not expect so marked a difference in all respects. I knew from long experience and innumerable tests, that no injurious organic matter would be found in the waters of the gravel stratum—the water shield of the strata above being an ample protection—but I did not expect so marked a difference in respect to the carbonates of lime, magnesia and iron. It will be seen in the professor's report that the water of the sand stratum nearer the surface carries sixteen per cent. more of carbonate of lime, seven hundred per cent. more of carbonate of iron, and sixteen hundred per cent. more of carbonate of magnesia than the waters of the gravel stratum, and the showing for volatile and organic matter is all one way, the volatile and organic matter in the waters of the gravel stratum being perfectly harmless. The volatile matter of the gravel stratum comes from vegetable matter deposited in this drift countless ages ago, and from which the carbonizing process of time has long since extracted all harmful properties. How different is the showing for the waters of the sand stratum nearer the surface; the volatile and organic matter carried in these waters under the exposure of our ordinary wells means sickness and death to those who drink them. The waters of the deep rock strata of course carry no organic matter, but show the presence of greatly increased quantities of all the carbonates, carrying from nine to twenty-five times more iron, and eleven times more of the carbonate of magnesia than is carried in the waters of the test-well. The

water of the gravel stratum carries enough of the carbonate of lime to make it a perfect drinking water, and yet it is soft enough to render it quite satisfactory for steam and laundry purposes."

I regard the lesson of this experience as exceedingly valuable to all who will study it. It confirms in the most striking manner the correctness of my theory relating to the character of the water carried in the earth's strata, and shows how easily a water free from all injurious impurities may be obtained in almost all localities. A knowledge of this will enable owners of wells everywhere, in city or country, by an easy and simple process, to protect their wells from contamination from any source, by sinking them in the proper manner and to the proper depth in the water stratum. The majority of wells everywhere, in city and in country, are of the pattern known as open wells —simply holes dug in the ground, only to the necessary depth to afford the small amount of water required for ordinary family uses. These holes are curbed up with stone, brick or wood, as the case may be; but in such manner as to afford little or no protection from contamination by the filth of the vicinity. The waters of such wells are almost invariably poisoned by the drainage from surface filth, cess-pools and privy vaults into them, and to an extent that would appal those using them, could they be made to realize the true situation. A very large percentage of the sickness and mortality prevailing in all communities is caused by the use of the waters of such wells, and it must be admitted that this condition of things is not in the highest degree flattering, in view of our loud claims to scientific advancement for this age. The moment we come to understand the simple, natural principles involved, it is no more difficult to so construct our wells that they will afford good water, than to so construct them that they will inevitably afford bad water. The simplest, cheapest and best mode for accomplishing this is by what is known as the tubular well process for private wells, and large caissons with impervious sides for public wells, where large supplies are required. These wells should be sunk to the proper depth in the water stratum of the locality, and in such manner that water can enter only from the bottom. Much has been said of late concerning the great mortality among the pilgrims to the famed sacred shrines at Mecca. An investigation by some scientist, who was not hampered by a blind and bigoted faith, developed the fact that the mortality was caused by the foul waters of the wells that supplied the drinking water for these devotees. These wells are of the pattern described above, simply holes dug in the ground, and exposed to the drainage of all the filth of the vicinity, and the people who throng this place are not noted for cleanly habits. If some enterprising Yankee would make a pilgrimage there, and reconstruct them in a proper manner, they would doubtless afford good water. It is not probable that such enterprise would be appreciated by these pious devotees, for in their blind faith they regard these waters as holy, and whatever harm comes from the use of them they cheerfully accept as a punishment from "Allah" for sins committed. Nor does it much matter as far as the Arab is concerned, but among the Anglo-Saxon races this kind of enterprise ought to be appre-

ciated. There is no proper excuse for drinking this sort of holy water in this country.

It is quite generally believed that the waters of rapidly running streams are self-purifying; that the current of their waters destroys and renders harmless all the impurities that find access to them. This is very far from being correct. Other things being equal, it is true that the waters of rapidly running streams are less dangerous than the waters of comparatively stagnant streams. In the case of stagnant waters, the conditions are favorable for the rapid propagation of a low order of vegetable and animal life, which, in its transition from life to death and decay, corrupts and poisons the waters and all those who drink them. In the waters of the rapid streams, the germs of this animal and vegetable life exist, but they cannot, to any great extent, assume the active life principle, the violent movement of the water preventing; but the moment we take these waters into our system, may we not bring about just the favorable conditions for their quick development, and in such form as to poison the system and breed disease?

Natural springs are generally regarded with great favor, and their waters are far superior to our ordinary wells, for their locations are usually more remote from contaminating influences, and their waters in a more active condition; still, these springs, being fed from the upper levels of the water stratum, necessarily carry more or less organic matter. Thus, look which way we will, we find that our only safety lies in the direction of obtaining our potable water supplies from sources free from all forms of organic contamination, and we can only obtain water in this condition by penetrating the strata of mother earth in the manner indicated above.

I believe that the soil of all habitable areas receives and will absorb and deliver to the strata below a sufficient percentage of the waters of the rainfall to meet all our demands for potable water, and in most cases for other uses also. These waters slowly percolate downward through the porous drift, completely filling all its spaces up to the level of the streams which drain the tributary areas. This body of water in the earth's strata is constantly being replenished by new supplies from the waters of the rainfall, and as constantly giving off its surplus to the streams, and is thus in ceaseless activity to the full depth affected by the streams. This constant flow and constant replenishment furnish the conditions necessary to preserve these strata waters in a proper degree of purity. If we penetrate too deeply, we get below the line of active flow, and thus obtain a water that, from its long standing, has become so impregnated with the soluble mineral matter contained in the earth's strata as to become unfit for use. On the other hand, if we do not penetrate deeply enough, we are exposed to all the organic contaminations existing at the upper levels of the stratum.

Long-protracted droughts cause a deterioration in the quality of the strata waters by arresting their active flow. During such periods the atmosphere also becomes less pure and salubrious from the long absence of the purifying influence of the rainfall. Hence we observe more sickness and ill-health during such periods. The recent strange and frightful mor-

tality in West Virginia and eastern Kentucky probably owed its origin to this cause. From long absence of rainfall, the strata waters became drained down to the stream levels, and the streams ceased to flow, the water remaining thus becoming stagnant and impure, and highly impregnated with decaying vegetable and animal matter. It is quite probable that the great abundance of mineral matter peculiar to that locality greatly aggravated the situation.

The two questions—Pure Water and Pure Air—are so intimately connected that it is difficult to comprehensively treat either without introducing both. It is as essential that the air we breathe should be in a proper condition of purity, as that the water we drink should be in a like condition. It requires more care and caution to procure pure air supplies for our dwellings than to procure pure water supplies. Nature supplies an abundance of pure air, as well as an abundance of pure water, but she requires us to obey the laws governing these elements, or to suffer severe penalties.

If we do not provide our houses with proper ventilation and drainage and maintain a proper degree of cleanliness in and about them, it will be impossible for us to obtain pure air supplies within them. However pure and salubrious the atmosphere may be, normally, in the locality we inhabit, we are required to perform our part faithfully, to maintain it in this condition. If we choose proper dwelling-places, where the atmosphere is naturally pure and salubrious, it is not a burdensome task to observe such sanitary rules and regulations as will tend to keep it in this condition. On the other hand, if we choose for our dwelling-places localities where the normal condition of the atmosphere is bad, we will be compelled to suffer, without being able to accomplish much by our own efforts to supply what nature has withheld. We cannot with impunity choose for our dwelling-places the low-lying deltas of rivers, or the vicinity of swampy tracts of country, with their stagnant waters and decaying vegetable and animal matter, and breathe their miasma-laden atmosphere. Many of the most terrible and destructive plague epidemics, which have from time to time afflicted humanity, have been caused by a disregard of this plain natural law. The historian Gibbon says that "Ethiopia and Egypt have been stigmatized in every age as the original source and seminary of the plague. In a damp, hot, stagnant atmosphere, this African fever is generated from the putrefaction of animal substances, especially the swarms of locusts, which are not less destructive to mankind in their death than in their lives. The fatal disease which depopulated the earth in the time of Justinian first appeared in the neighborhood of Pelusium, between the Serbonian bog and the eastern channel of the Nile. Contagion is the inseparable symptom of the plague, which by mutual respiration is transferred from the infected persons to the lungs of those who approach them. While philosophers believe and tremble, it is singular that a real danger should have been denied by a people most prone to vain and imaginary terrors; yet the fellow-citizens of Procopius were satisfied by some short and partial experience that the infection could not be gained by the closest conversation. But this fatal security, like the predestina-

tion of the Turks, must have aided the progress of the contagion. No restraints were imposed upon the free and frequent intercourse of the Roman provinces; from Persia to France the nations mingled, and infected by wars and immigration and the pestilential odors which will linger for years in a bale of cotton, imported the disease into the most distant regions. The winds might diffuse the subtle venom, but unless the atmosphere was previously disposed for its reception, the plague would soon expire in the cold and temperate climates of the earth. Such was the universal corruption of the air, that the pestilence which burst forth in the fifteenth year of Justinian's reign was not checked or alleviated by any change of the seasons, and not until the end of a calamitous period of fifty-two years did mankind recover their health, or the air resume its pure and salubrious quality. During the first three months, at first five and then ten thousand persons died each day in Constantinople; many cities were left vacant; in several districts in Italy the harvest and the vintage were left to wither on the ground. The triple scourge of war, famine and pestilence afflicted the subjects of Justinian, and his reign is disgraced by a visible decrease of the human species, which has never been repaired in some of the fairest portions of the globe."

This terrible and appalling lesson should indelibly impress us with the importance of *co-operation* between *natural* and *human* agencies. Doubtless, if the people of Justinian's time had been possessed of a higher degree of medical knowledge, their sufferings would have been greatly mitigated, but no human agencies could have successfully coped with the dangers surrounding them. Such localities as the Serbonian bog and the Nile deltas are not yet finished and ready for the occupancy of man, and if mankind would keep away from them, the contagion of the poisoned atmosphere would not be spread broadcast over the earth. There is ample space fit for occupancy on the face of the earth to meet all the requirements of the human race, without invading the pestilential districts.

But our task is not finished in choosing for our dwelling-places localities where the natural conditions are favorable; we are still required to perform our part faithfully, or these favorable conditions will not continue.

It would prove a very difficult task to ascertain the extent to which the atmosphere is corrupted and rendered unwholesome by the smoke and gases of our countless furnaces and manufacturing establishments, and whatever the danger, there is difficulty in avoiding or removing it; but our greatest danger does not lie in this direction, and is not beyond our power to avert. The outside atmosphere of even a Pittsburgh is far less impure and dangerous than is the atmosphere within our average dwelling houses; not one in one thousand of our houses is provided with proper ventilation, and still fewer of them with proper drainage facilities. Comparatively few of our cities are provided with public sewer systems, and even these are faulty and inadequate; by far the greater number have no public sewers whatever, and in the absence of public sewers with which to connect our private house drains, it is entirely impracticable to estab-

lish and maintain such drains, without aggravating instead of improving the sanitary conditions about our dwellings.

It is true that in most of our modern houses some attempt is made to establish a drainage system, but in every case where a properly constructed public sewer is not available to connect with—and these constitute fully ninety per cent. of all the buildings in the country—this results in aggravation of the situation. In the absence of public sewer facilities, that abominable death-trap, the cess-pool, is in almost universal use. The usual mode of construction for a cess-pool is to dig a hole in the ground near the house, and conduct all the waste and soil pipes of the house into it, loosely wall up the sides of the excavation to within a few feet of the surface of the ground, cover it over tightly, and it is ready for use. In some cases, ventilating tubes are provided, but in the great majority of cases no such means are provided, beyond the pipes *leading back into the house*. Often these excavations are carried down to the water stratum underlying the locality, to promote the escape of the fluid contents of the cess-pool. The water supply of the family is usually taken from this same stratum, and as at best the well is not far removed from the cess-pool, it does not require any strain of the imagination to picture the condition of this water, a little farther along we will analyze the atmospheric conditions within the house, produced by the use of these abominations. The average term that these cess-pools last is, perhaps, five years, the strata in the vicinity becoming so filled with filth that no more can be absorbed. When this time arrives, another is constructed, until frequently we have half a dozen in the same yard. The gases generated by the putrifying contents of these hidden death traps are among the most deadly known.

During the past summer, three men lost their lives in a hotel cess-pool in a small town in New Jersey. The waste pipes had become clogged; the cess-pool was opened and a man sent into it to make an examination; before this man reached the bottom, he was overcome by the foul gases and fell from the ladder by which he was making the descent; instantly another started to his rescue and met the same fate; a third made the attempt, with the same result. In the space of as many minutes, three lives were sacrificed in this horrible death trap. Every city and village in our country is full of just such death traps, and it will be impossible to establish or maintain any fair sanitary condition until such abominations are abolished and prohibited by law. It would be much safer to follow the custom of the Chinese in the disposal of the filth of our dwellings; instead of depositing it in cess-pools, where by constant accumulation and decay the most deadly gases are generated, they dispose of it openly, upon the surface of the ground, where the free and rapid action of the elements prevents its assuming the deadly character peculiar to the cess-pool, and very soon renders it harmless, and besides, in this way much benefit is derived from its fertilizing properties.

From time to time, our medical authorities are confronted and confounded with new diseases, or with new and strange forms of old diseases, which they are unable to explain, or to trace to any adequate cause. I have no doubt that a full and clear investigation of the prevailing mode of

house drainage and ventilation will clear away the whole mystery, and unmistakably show that not only all these new and malignant forms, but all forms of zymotic disease are caused by bad water and bad air, and that the water and air are made bad by our abominable system of house drainage.

The terrible disease known as diphtheria, of which so little is known by our physicians, is, I fully believe, clearly traceable to this cause. This disease would prove as dire a scourge to humanity to-day as were the plagues to the ancients, were it not for the protection afforded by our greater knowledge of medicine and of sanitary laws. This disease has prevailed in the beautiful city of Kalamazoo during the past autumn in epidemic form, and still prevails to some extent. The citizens of Kalamazoo pride themselves upon the cleanliness and tidiness of their city. Three hundred cases of this dread disease have developed, more than twenty per cent. of which have proved fatal. An examination of the records of the Health Office shows that more than ninety per cent. of all these cases have developed in localities where the family water supply was from ordinary wells, the water of which is known to be contaminated, and where the drainage facilities and general sanitary surroundings were bad. The few remaining cases, where the water supply was taken from the street mains, and where the sanitary surroundings were apparently good, were doubtless caused—except cases of contagion—by poisoned air from the foul gases generated from the *buried* filth of the vicinity. When we find a malignant case of diphtheria developed in a house where everything is seemingly kept in scrupulous cleanliness, and where the water supply is unexceptionable, it is apt to lead the casual observer to say, "Surely, this case does not originate in any uncleanliness or bad sanitary condition of the locality;" but if this same observer could have exposed to his gaze the foul contents of the, perhaps, half dozen cess-pools which lie smouldering under the beautiful lawn at the door, the gases from which are constantly oozing into the house, he would not be surprised at the result—diphtheria.

The public sewer system of Kalamazoo is excellent, so far as it goes, but as yet only a small number of the buildings are connected with the public sewers; of the more than three thousand buildings of the city, less than three hundred are thus connected, leaving still *ten cess-pools* to *one sewer* connection. And even in the cases where the cess-pool connections are severed by reason of connection with the public sewer, the cess-pools with their foul contents are still left in the door yard.

The damage arising from these cess-pools is by no means abated by simply disconnecting the pipes which lead from the house to them; their foul gases will find other avenues of entrance. The porous soil between these cess-pools and our cellars always affords an avenue for the entrance of this foul air; and in cold weather, while frost has hermetically sealed the surface of the ground outside our dwellings, there is no other outlet for these pent-up gases, and they thus enter our dwellings, and like a thief by night rob us of health and life, while slumbering in fancied peaceful security.

We often note with surprise the increase in extent and malignity of these diseases upon the approach of cold weather. Naturally, we look for a diminution in their prevalence when frost sets in and arrests the fermentation and decay of vegetable and animal matter all about us, and this would be the case were there not other forces at work to counteract and bring about a different result. It is entirely within our power to expose these opposing forces and protect ourselves against them, but to accomplish this we must conform to and obey nature's laws and regulations, not oppose them.

There is no doubt but that the outside atmosphere is purer and more salubrious in cold weather than in hot weather; but of the air within our houses the reverse is generally true. In hot weather the temperature is higher outside our houses than it is inside, and in consequence the natural flow of foul gases is *outward*. As cold weather approaches, we shut our houses up closely, and keep the temperature at a much higher degree inside than prevails outside, and we thus reverse the flow of these gases. It is now that these deadly cess-pools prove most dangerous, forcing their foul gases—under these favorable natural conditions—into our cellars and basements and throughout the entire house. The large quantity of vegetable matter contained in our cellars for the winter use serves to help on and aggravate the situation. To escape these dangers we must remove the cause. The cess-pool should be abolished and obliterated, and the practice of burying the filth of our dwellings in our door-yards prohibited by law. All cities and villages should be required by law as much to provide public sewer facilities as public school facilities. The first is as necessary as the second. A healthy physical status is necessary to a healthy mental one. A person with poor health and a good school education cannot accomplish more for himself or for the world than a person of equal natural ability, with good health and poor school education. Of the two, nature doubtless intended to place health above all else.

Lines of sewers should be provided for every street of every city and village in the land, and every householder should be required by law to connect his premises, by means of proper drains, with the public system. The question as to the kind and character of sewer that should be adopted is of the very first importance. The common type of sewer and storm drain combined is a monstrosity and should be prohibited. Such a sewer is simply a prolonged cess-pool, most perfectly adapted to the production of foul gases. If we attempt to make use of the same drain for carrying the storm waters and sewage of a street, it must necessarily be made so large that at all times, except during the prevalence of rain storms, the solid matter of the sewage is deposited along the sewer, to ferment and putrify; hence, such sewers are always filled with sewer gas, the same as cess-pools; this gas gets back upon us in our houses through the connecting pipes, which are never so perfectly trapped as to be proof against it. If, instead of this huge drain, we use a smooth pipe, only of the proper size to perform the simple, legitimate office of a sewer, there would never be any filth deposits along its line; all the sewage would pass through quickly and be disposed of while still in

its fresh state, thus offering no opportunity for the fermentation and putrefaction essential to the production of sewer gas, consequently *sewer gas is never found to exist in this class of sewer.*

The way is so plainly open for a most radical improvement in our system of water supply and air supply for our dwellings, that there is no adequate excuse for the apathy and lack of interest manifested by the mass of our people in these vital questions. The American people are not slow to act, and to act effectively, when convinced that action is necessary; yet it is a singular fact that while, as a people, we are at all times ready, with almost a blind faith, to support the wildest schemes for our financial improvement, we bestow scarcely a thought in the direction of sanitary improvement, which is more important to us than all the rest, and upon which all else so much depends. When we come to a full realization of this truth, and to properly act upon it, we will exterminate one-half the diseases which now afflict us.

The following brief account of some very interesting experiments made in London, England, to test the influence of the atmosphere upon the waters of the rainfall, has just come to hand:

Those who complain of rainy weather do not realize that not only does the earth need washing, but also the air which we breathe so many times a day. The effect of rain upon the air and the contents of the rain have been made the subject of examination by the meteorological council of London during the past two years. Three stations were used for collecting the rainfall—one at St. Bartholomew's Hospital, another at Upper Hamilton Terrace, in the northwest portion of London, and a third at Hackney. It was found the rain contained twice as much impurity as that which fell at the suburban stations, and the impurities gathered at all the stations were in the same proportion.

The chief impurities were found to be sulphates and chlorides, and it was discovered that the rain caught at St. Bartholomew's was always contaminated with soot and disagreeable to the taste. The summer rain is more impure than that of winter, and in the mixture of London rain and soot a trace of arsenic is found. In summer the rain was shown to contain a larger quantity of sulphates than chlorides, which was supposed to be owing to the decomposition of animal and vegetable matter during the warm months. After the rain has been falling for some time, the impurities are found to diminish, and the satisfaction with which we breathe in the washed air after a rainfall is an evidence that our senses bear spontaneous testimony to its purification.

DEVIATION OF SHIP'S COMPASSES.

By H. C. PEARSONS, of Ferrysburg.

At a former meeting of this Society the writer read a paper on the "Conversion of Compass Courses." The object of the present paper is to show how to find the errors which make a Conversion of Courses necessary; and to consider the causes of those errors,—the methods of separating those causes, and of finding their relative effects in disturbing the compass. In so doing, it will be necessary to introduce the Deviation curve, which was explained in the former paper.

The earth is a vast magnet, acting by induction on all iron, which in turn acts on other iron, or other magnets. The consequence is, that the magnetized needles in the compasses of iron ships are disturbed from their normal positions by the magnetism of the iron in the ship. With the compass near the stern of the vessel, as is usually the case with the standard compass,—this disturbance consists of an attraction on the north end of the needle, so that, in turning the ship around in azimuth, the needle will follow the ship's head;—or the effect may be a repulsion on the north end of needle, in which case, as the head moves in one direction, with regard to azimuth, the north end of needle will move in the opposite direction; and, in either case, the needle will make one complete double oscillation, analagous to that of the pendulum, while the ship's head makes one complete revolution in azimuth,—the amplitude of the oscillation depending on the amount of magnetism in the ship, as compared with the directive force of the earth's magnetism.

The effect of this oscillation of the needle, on the apparent azimuth of the ship's head, may be graphically represented, by the following operation, the compass being placed near the stern, and in the central longitudinal line of ship.

Suppose that the ship is turned completely around in azimuth, about a vertical line passing through the centre of the compass; also that the compass has a motion of translation along the magnetic meridian,—say to the south,—through a distance equal to the circumference of a circle, whose diameter is the length of the needle. Then, if the needle were not disturbed, its north end would move in a right line representing the magnetic meridian. But, if acted upon by an attraction from the head of the vessel, the north end will follow the same, so that with motion to the right, the needle will describe a curve to the right, attaining its greatest angular distance from the magnetic meridian, when the ship's head is east, magnetic. As the ship's head continues to move from east to south, the needle falls back towards the magnetic meridian, which it reaches simultaneously

with the ship's head. As the ship's head passes from south, by the west, to the north, the north end of the needle makes a swing to the left, and back again to the magnetic meridian. Thus by the combined motion of this double oscillation, and the motion of translation above referred to, the north end of the needle traces out the reversed curve shown, (see diagram). By dividing this vertical line into 32, or 360 equal parts, we have an azimuth scale in points or degrees as desired—the reading of this scale downwards corresponding to the reading of an azimuth circle from left to right.

In navigation this displacement of the needle from its normal position is called *deviation;* the angle between the magnetic meridian and the astronomical meridian is called *variation;* and the algebraic sum of these two errors is sometimes called *total variation*, sometimes the *error* and sometimes the *correction* of the compass.

Thus far the deviation curve is ideal, but its construction and use are of the first importance to navigators, as, by its means, when constructed from observation on a few points, the deviation on any point may be known by inspection.

The methods for the construction of the curve, usually given in works on navigation, suppose the ship's compass to be provided with sights and so located as to sweep the whole horizon, except as it may be obstructed by the ship's masts, smoke-pipe, or deck-houses. It is then only necessary to compare the azimuth of some distant mark, called an azimuth mark, as given by the ship's compass, with the vessel's head in different directions, with the magnetic bearing of the same mark from the ship, as indicated by a compass in line with the ship and azimuth mark, and away from the ship's magnetism or other disturbing causes, care being taken that the mark is so far distant that its bearing is not sensibly changed by change of place of the compass in swinging ship. The differences between the magnetic bearing of the mark and the several compass bearings are the several deviations, corresponding to their respective compass azimuths.

As those accustomed to this work are particularly liable to mistake the sign due to deviation, the following hints are offered to keep them from this mistake. Though azimuth is regarded as reckoned from the north meridian, and to the right, continuously to 32 points, or 360°,—in practice it is reckoned from any one of the cardinal points, and in either direction, right or left, as occasion may require. If the compass azimuth and the magnetic azimuth are between the same cardinal letters, and the former is numerically the smaller, the deviation is in the same direction as that in which the azimuth is reckoned; but if the compass azimuth is numerically the greater, then the deviation is in the contrary direction.

Again, if the magnetic bearing of the object is so near the margin of the quadrant, that, in consequence of the deviation, the ship's compass shows it at the margin, or in the adjoining quadrant, then the deviation is in a direction *from* the adjacent quadrant. A little consideration will show the reason for this rule. Deviations to the right or east are to be marked with the plus (+) sign, while those to the left have the minus (—) sign.

It may not happen that a distant mark can always be found, particularly in port;—in this case a process of reciprocal bearings must be adopted.

nor are the compasses of all vessels so located that they can observe an azimuth—many of them being shut up in a pilot house. In this case the *dumb compass or card* must be introduced for the purpose of measuring the motion of the ship in azimuth, from point to point of observation.

The dumb compass, or card, differs from the surveyor's compass, in having no needle; in having the sight movable on the graduated limb; and also in having the graduated limb movable past an index or vernier, so that readings can be had from the limb by two indexes. To use this compass, the zero line over which the graduated circle revolves must be set so that it is strictly parallel with the centre line of the vessel. Then, if the sights are adjusted to the bearing of the azimuth mark, as indicated by the shore compass, the zero line of the dumb card will be in the magnetic meridian—the forward side of the card being towards the head of the vessel—and the reading of the card by the lower index, or that one past which the card revolves, is the magnetic bearing of the ship's head. The difference of the simultaneous reading of the dumb compass and the ship's compass will be the deviation due to the heading of the ship as indicated by the ship's compass.

But with no distant mark, the shore compass becomes the azimuth mark; and the bearings of the dumb card on ship from the shore compass must be repeated on the dumb compass at every observation. Some observers back-sight on the shore compass, and then reverse the bearing before setting the sights of the dumb card; but it is better to let the dumb card "look" in the same direction as the shore compass, and thus avoid the danger of mistake in reversing. If the shore compass is beyond speaking distance, the bearings of the dumb card from it may be written on a blackboard, and read with the ship's glass, or other telescope.

A sufficient number of observations having been made in each quadrant—say six or eight—the resulting deviations are to be set off as ordinates, on their respective compass courses, to the right or left of the magnetic meridian, according as they are east or west deviations, when a curve traced fairly through the extremities of these ordinates will be the deviation curve desired, (see diagram.) These deviations must be measured by some scale, though not necessarily that by which the azimuth is measured. This scale may be written across the top and the bottom of the page, at right angles to the line representing the magnetic meridian—the zero of scales being on that line. It is well to make this scale larger than that by which azimuth is measured, to show more clearly small deviations, on the same principle that railroad engineers make their vertical scales larger than their horizontal scales for showing profile.

In order to utilize this curve, lines must be drawn diagonally across the two scales so as to intersect them at points having the same numerical value. As the vertical scale reads downwards, corresponding to increase of azimuth reading to the right, these diagonal lines must be drawn through the magnetic meridian, upwards to the right, and downwards to the left. The diagonal through the first point of the vertical scale must be drawn through the point indicated by 11¼°, on the horizontal scale, etc. If any course be then taken up on the magnetic meridian, and projected

on the curve, the difference of the azimuth readings indicated by the two points will be the error of the compass due to deviation.

To combine this error with variation, draw a vertical line, parallel with the magnetic meridian and through that point of the horizontal scale, at top and bottom of the page which indicates the variation for the locality, to the *left* for easterly variation, to the *right* for westerly variation. This line represents the true or astronomical meridian, for the locality, having the given variation. Then, to find the "total error" of the compass, for any given course, take up the given course on the true meridian, and project it on to the curve, by a line parallel with the oblique lines. The difference of the readings of the two points by the azimuth scale, is the total error of the compass, resulting from "Variation and Deviation." This is always the error found at sea, from an observation for azimuth. The diagram above described will give the local navigator great command of his compass, in the finding of its errors, in the conversion of courses, in shaping courses, in finding courses made good, etc.,—explanations for which will be found in the paper on the "Conversion of Compass Courses," above referred to. (Proceedings for 1882.)

Those who are to navigate between remote countries must have, in addition, some knowledge of the forces that act on the compass needle, and of the laws by which these forces vary in different geographical positions, or his compass will avail him nothing. On the contrary, it will be worse than useless, as it may lead him into the most serious disaster. Magnetism is one of the imponderable agents by which the material creation is actuated, in a manner somewhat analagous to that by which the human mind actuates the physical man. The intensity of the earth's magnetism is very different in different localities, though it is approximately uniform in the direction of longitude. It is at its minimum along a line approximately following the equator, and at its maximum between latitudes 70° and 80°. The line of minimum intensity is called the magnetic equator, from its proximity to the geographical equator. On this line, the magnetic needle takes a horizontal position; but in going towards the pole in either direction, the end towards the pole dips below the horizon, the angle of the dip being called the *magnetic latitude*. Thus, here, the north end of the magnetized needle, unbalanced by a counter weight, would take a position in the magnetic meridian, with its north end about 75° below the horizon, i. e., the magnetic latitude of this place, is about 75°.

But as our compass needles are horizontal, we are obliged to consider this inclined magnetic force of the earth as the resultant of two forces—a vertical, and a horizontal one. The horizontal component is that force that gives direction to the needle. As it is the projection of the earth's entire force on to the plane of the horizon, it has its maximum on the magnetic equator where the total force is a minimum, and it vanishes at the magnetic poles, where the total force is at its maximum. A line joining the poles of the dipping needle, is called the "*line of force*," and a plane perpendicular to this line, is called the "*neutral plane*," or "*magnetic equatorial plane*." In passing this plane from either pole of the dipping needle,

the sign of the magnetism changes: so that a rod of iron or steel, whose length is in this plane, will not be affected by the earth's magnetism.

The *vertical component* has different properties in different latitudes. In north magnetic latitude, its upper end is always on the south side of this neutral plane, and therefore always acts with that kind of a force that is in the south end of the magnetized needle. Regarding the horizontal component as unity, the intensity of the vertical force will be represented by the tangent of the dip-angle—or tangent of the magnetic latitude. Consequently, at the magnetic equator, where the dip is nothing, the force vanishes, and in passing the equator changes sign, so that the force that was an attraction in north latitude becomes a repulsion in south latitude.

A peculiar effect of the horizontal force in inducing magnetism in soft iron is, that it has its maximum effect at the quadrantal points—its maximum easterly deviation with vessels being at N. E. and S. W., and the westerly deviation being at S. E. and N. W., and varying between the cardinal points as the sine of twice the azimuth. The reason of this law will be seen when we recollect that, with the ship's centre line in the magnetic meridian, the forces of both the earth and ship act in the same line, and therefore produce no deviation. When the ship's centre line is east and west, it is also in the neutral plane, so that there is no force, and consequently no deviation; whence the maximum deviation is at the quadrantal points, as stated. This disturbance of the needle, is called quadrantal deviation, from the fact of its changing sign in each quadrant, being +, —, +, —, in going from the north by the east, south and west to north again. A peculiarity of this part of the deviation is that it is generally small in amount, as compared with the other parts, and it is practically constant, in the same ship, during the life of the ship, and in all geographical positions, and therefore it gives the navigator but little trouble.

The deviation resulting from the vertical force has its greatest value when the ship heads due east or west, magnetic; while with head north or south it is zero, for the same reason that quadrantal deviation is nothing at these points. It is called *Semicircular Deviation*, for the reason that it has but two signs, +, —, east and west. From the magnetic meridian, it increases each way to the equatorial line, or line of E. and W.—as the sine of the magnetic azimuth; whence a curve representing this part of the deviation is strictly a curve of sines—the developed arcs of the azimuths being the abscissas, and the sines of the arcs, or azimuths, being the ordinates. Its amount at east or west being known from observation, its amount at any other point may be computed.

Also, if the quadrantal deviation has been found, the deviation at the quadrantal points, due to the vertical force may be computed; for these deviations are proportional to their inducing causes, which are as the horizontal to the vertical force—or as unity to the tangent of the dip.

The disturbances above mentioned pertain especially to soft iron. Those produced by hard iron are quite different.

Hard iron receives induced magnetism more slowly, but it retains the magnetism received longer than does soft iron; and if, while its longest dimension is out of the neutral plane, the iron be hammered, twisted,

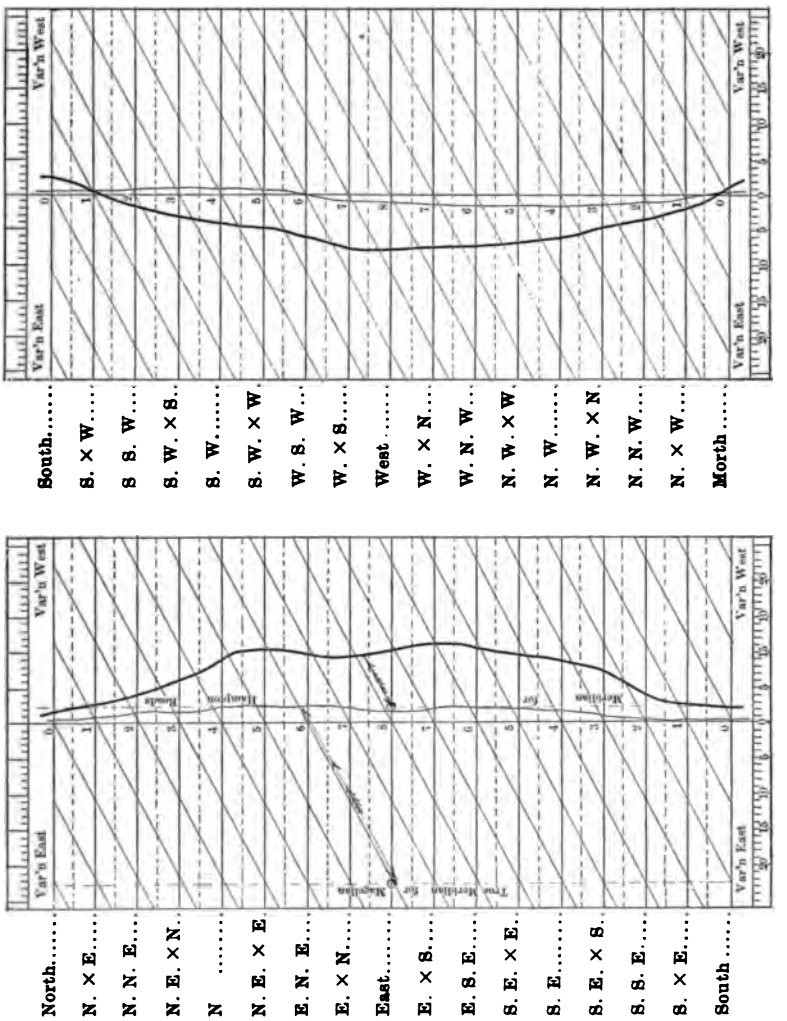
rolled, punched, or otherwise violently treated, the magnetism is not only increased, but in a measure permanently fixed, causing the hard iron for the time to act on the needle as a permanent magnet by simple attraction or repulsion, as the case may be, in all geographical positions, and with the ship's head in all directions, thus differing from the vertical; but in the same latitude in which the vessel was built, producing a deviation identical in character with that produced by the earth's vertical force and its boundary being also strictly a curve of sines so that its deviation is also semicircular. Therefore, in the latitude in which the vessel was built, these two deviations come together by addition; but in crossing the magnetic equator, the sign of the hard iron deviation remains constant, while that of the soft iron changes, so that, on the opposite side of the equator, their difference is the deviation, that due to the hard iron being generally much the greater. But this hard iron magnetism is not strictly permanent, as its name would imply. In a new built vessel its intensity diminishes rapidly during the first few years, after which it becomes comparatively permanent, on which account it is called *sub-permanent magnetism.*

There is yet another source of complexity to be considered. The poles of this "hard iron" magnetism take position in or near the magnetic meridian, during the time of the building of the vessel. On this account the "line of force," i. e., the line joining the opposite poles of the fixed magnetism, seldom or never is contained in the ship's plane of symmetry; but we nevertheless wish to know the amount of the ship's force, acting in the direction of the centre line, fore and aft, and we are therefore again under the necessity of resorting to the potent theorem of the composition of forces. To illustrate: Suppose an iron ship built with her plane of symmetry strictly in the magnetic meridian. Then the two parts of the semicircular deviation, being both curves of sines, would produce a symmetrical curve. But, suppose that the ship's centre line is out of the meridian, for example the ship's head bears N. two points E. Then the line of ships' force will lie in the vertical plane cutting through the vessel from starboard quarter to port bow. The neutral plane in this latitude, being about 15 degrees above the northern horizon, would cut the vessel's decks across her bows, and the keel a little forward of the stern. The forward and lower portion of the vessel, being below the neutral plane, will have a magnetism like that in the north end of the needle, while the upper, after portion of the vessel will have the same kind of magnetism that is in the south end of the needle. As the line of the fixed magnetism of the vessel is two points to the left of the ship's centre line, the maximum deviation due to the hard iron will not be attained till the ship's head is two points past the equatorial line in swinging to the right. This produces an irregularity in the form of the curve.

It is sometimes desirable to know what portion of the total force of the ship acts in the fore and aft line. The cosine of the angle which the "line of force" makes with the centre line, is the measure of this part of the force in terms of the *total force* as unity.

The change in these forces, and the necessity of being able to antici-

DEVIATION CURVES OF U. S. STEAMSHIP "MONADNOC."



Swung for deviation (thick-line curve) at Hampton Roads, Lat. 37° N., Nov. 1, 1865.
" " " (thin-line curve) in Straits of Magellan, Lat. 53° S., Feb. 10, 1866.

pate these changes, cannot better be illustrated than by giving an example from the United States Steamer *Monadnoc*, from Philadelphia to San Francisco, in 1865 and 1866, as reported by Prof. Wm. Harkness, U. S. N., who was detailed for the voyage. The *Monadnoc* is a wooden-built ship of 260 feet length, 52 feet beam; her sides to the depth of five feet are clad with six inches of iron, her decks are covered with three inches, and she has two gun turrets plated with eleven inches of iron.

The curve represented in the accompanying plate shows, by the full heavy line, the deviation of the ship's standard compass, as determined by swinging ship at Hampton Roads, latitude 37° N., November 1, 1865. The thin line represents the deviation curve of the same standard compass obtained by swinging ship at Sandy Point, Straits of Magellan, latitude 53° S., February 10, 1866. Here, a marked reduction of deviation is seen. It is the business of the navigator to explain, or rather to anticipate the change in the amount of this deviation.

It has been shown that the deviation due to the vertical force of the earth vanishes at the magnetic equator, and changes sign on crossing it; also that the portion of deviation due to the fixed or hard iron force remains constant in all latitudes, except that the force producing it may diminish by time. Also that the deviation resulting from this force varies inversely with the horizontal force, and that it is generally much larger than that resulting from the induced magnetism of soft iron.

Since the vessel has passed from magnetic latitude 70° N. to 55° S., the portion of deviation (semicircular) due to the inductive magnetism of soft iron has not only vanished, but appeared on the other side of the equator with a contrary sign, and with a value in proportion to the tangent of 55° to that of 70°, or as 1.43 to 2.75 = .52 of its former value. That is to say, in crossing the equator the soft iron deviation not only vanishes, but takes a little over one-half of its value from the hard iron deviation. Again, the horizontal force at Hampton Roads, is to that at Sandy Point, in the Straits of Magellan, in the proportion of 11 to 16 nearly, so that the resulting new deviation will be about three-fourths; that is to say, the hard iron portion of the semicircular deviation has not only been reduced from change of horizontal force by one-fourth of itself, but it has been diminished by more than half of the soft iron portion of the semicircular deviation. Whence the hard iron deviation is nearly extinguished, and were it not for the quadrantal deviation, which remains nearly constant under all conditions and at all times, but little deviation would remain at Magellan.

There is still another factor affecting the total error of the compass, the change of variation. At Hampton Roads, this was about $2\frac{1}{2}$° W., while at Magellan, it was 22° E. The combined effect of these causes, variation and deviation, for any course, say east, at the two places, is seen by taking up the given course on the true meridian for each place, and projecting it on to the corresponding deviation curve. Thus, taking up due east on the true meridian for the variation at Hampton Roads, and projecting it on to the deviation curve for that station, the compass course to get due east by chart is five-eighths of a point north of east, or E. § N. In like manner the compass course to attain due east, at Magellan, is E. $2\frac{1}{8}$ N.

This disposition of hard iron to change its intensity makes it important to know, from time to time, the power of the ship's force as compared with that of the earth. This ratio is found by vibrating a horizontal needle from the plane of the meridian and observing the number of vibrations in a given time. Then, from the well known principle in dynamics, that the power producing vibrations varies as the square of the number of vibrations in a given time, the directive power of the ship, as compared with that of the earth, is readily determined. This test involves observations, both aship and ashore; but there is a simple and easier method of finding the directive power of the ship's magnetism.

By the theorem of the composition of forces, if two forces act upon each other at right angles, their resultant takes the direction and magnitude of the diagonal of a rectangle, whose two adjacent sides represent the two forces in question. Then, having observed the deviation caused by the ship, with the disturbing element at right angles to the magnetic meridian, the sine of the deviation represents the ship's force, while the cosine represents the earth's directive force. Then the tangent of the deviation is obtained by dividing sine by cosine, that is to say, *the tangent of the deviation is the measure of the ship's directive force, in terms of the earth's directive force as unity.* A comparison of the tangents of deviations on different ships, with the corresponding forces, as determined by the method of *vibrations*, not only confirms the correctness of the method by tangents, but also shows the wonderful precision attainable by the other method.

Many other points could be presented, of equal or greater importance than those which have been considered. Those wishing to look further into this subject are referred to the "*Admiralty Manual*" for 1874, and the papers of foreign societies, as printed by the "*Bureau of Navigation*," Washington, 1867.

SUGGESTIONS TO BEGINNERS IN LAND SURVEYING.

By D. SKEELS, Grand Rapids, Mich.

R. M. Bache, Assistant U. S. Coast Survey, says: "Surveying, though in a certain sense simple, is in practice extremely difficult, requiring the highest kind of skilled labor. It is not a little dependent upon manual dexterity and general functional ability, which practiced apart are a subtle product of individual organization. These are as necessary as the most perfect comprehension of method. A surveyor, if a good one, is an excellent compound of exercised natural qualities."

As he enters the woods, he must be able at sight to detect the difference between the Indian's trail and the trapper's line; the trapper's line and the surveyor's work; the surveyor's random and the true line, and whether the bearings on the tree are the work of the surveyor or the hedgehog; whatever marks, by who or what made and for what purpose—this kind of knowledge is requisite to understandingly prosecute the calling. It is quite impossible to give fixed rules that will apply in all cases and at every stage of the work. The system of surveying has at different periods and in various localities been so modified that the surveyor must know by which of the several methods the township was subdivided.

About the first, and I think the first, enactment in reference to the surveying of public lands was passed by the Congress of the confederation in May, 1785, for the surveying of the Western territory, to the effect that said territory be divided into towns six miles square, by lines running due north and south, and crossed by others at right angles.

The second section of an act approved May, 1796, in addition to the above, provides that one-half of the townships, taken alternately, be subdivided into sections of 640 acres each, by parallel lines each way every two miles, and making a corner on each of said lines at the end of each mile. This act, and one amendatory, approved May, 1800, form the basis of our present system of the subdivision of townships into sections.

The first subdivision of the townships of this state into sections was generally by commencing at the corner of sections 35 and 36 on the south boundary of the township, thence north parallel with the east range line 80.00 chains, marking there the corner for sections 25, 26, 35 and 36, thence east to the range line, closing on the corner of sections 25 and 36. If the distance between these corners be more or less than 80.00 chains, the ¼ section post is set in the centre and the length of the mile noted. In like manner proceed north and east to the north boundary of the township, properly to the south boundary of the township north, there estab-

lishing the corner for sections 1 and 2, noting the difference, if any, between it and the corner of sections 35 and 36 of the township north, making the north and south miles 80.00 chains; and if the distance on the line between sections 1 and 2 be more or less than 80.00 chains the excess or deficiency is reported in the last half mile. It would seem that, if the U. S. Deputy had any object, aside from dollars and cents, in the tracing of these lines, it was to keep just 80.00 chains from the east range line. Returning to the south boundary from the corner of sections 34 and 35, the surveyor proceeded as before, north and east. The tier of sections on the west he was not obliged to close on the corners of the sections in the adjoining township, but to report the excess or deficiency in the west half mile.

Some of the surveyors of those days differed from the politicians of to-day in that, instead of trying to cover their tracks, they failed to make any tracks at all; and it soon became necessary to institute a system of resurvey, which was generally by commencing at corner of sections 13 and 24 on the east range line, thence running a random line six miles west to the west range line, setting temporary stakes at each half mile, closing on the corner of sections 13 and 24 of the township west, making bearings to it for the corner of sections 18 and 19. After correction, this random line was taken as a base line, and from the section corners on this line random lines were run north and south to the north and south boundary lines, closing on the corners on those boundary lines, the excess or deficiency north being reported in the last half mile, and south divided equally in the three miles. From the section corners on the north and south lines, random lines were run east or west, closing on the section corners in boundary, placing the quarter section posts in the center and thus proceeding to a finish.

The Act of 1805, Feb. 11, annulled all previous acts in conflict with its provisions and provides, first: All corners marked in the surveys returned by the Surveyor General shall be the corners of sections which they were intended to represent.

Second, the boundary lines run, marked and returned by the Surveyor General shall be the boundary lines of sections for which they were intended.

We know of many a half mile this act has established that deputy U. S. surveyor's foot never trod. As these lands pass to the hands of private individuals, the government corners and lines marked in the field and returned by the U. S. deputy to the Surveyor General must govern in determining the boundaries of all legal subdivisions when they can be found. When they are missing, what then? There's the rub.

From instructions sent out from the General Land Office Department, we are to infer that missing lines and corners must be restored to the exact locality they originally occupied. This is quite imperative. The best evidence of the location of an original corner is the monument placed at that corner at time of original survey; also the best evidences of the location of lines are the monuments placed on those lines at the time of the original survey. Justice Cooley says in his excellent article read before

this Association: "It is by no means uncommon that we find men, whose theoretical education is thought to make them experts, who think that when the monuments are gone the only thing to be done is to place new monuments where the old ones should have been, and would have been, if placed correctly." He adds, "This is a serious mistake."

What is evidence of the position of a landmark?

My experience will warrant me in saying, first, that of some person interested or uninterested, who from some fixed object, by range and distance, or by range or distance, can locate.

Second, if in a former subdivision two points have been preserved.

In September, 1881, we were called on to locate the subdivision corner on the east side of the S. E. ¼, sec. 19, T. 8 N., R. 9 W., and to mark the line east and west between the S. E. ¼ and N. E. ¼ of said S. E. ¼ of sec. 19. Arriving on the ground, we found all interested parties present. We learned that the corner had been placed some twenty-five years previously, but had not been cared for and not seen in some fifteen years; that a small stream passed along so close to this line that it was claimed to be on both sides of it. Also that a deputy county surveyor, about one year previous, had consumed a day and a half with two assistants in *establishing* the corner of sections 19,20, 29 and 30, which he had treated as a lost corner. We also learned that when the party who owned the most of section 20 approached him with the remark that he could show him the old corner, the deputy mildly replied that he wished him to understand that he was there to *establish* that corner, and when he wanted any of his advice he would call for it; and he proceeded to *establish* it by setting a large boulder, into which he drilled a hole, which he hammered full of lead, and from this subdivided section 30.

We examined the premises; a bearing mark on a white oak stump was the original bearing, but course and distance would not correspond to the stone with lead. We made the remark that some of the men present, being old settlers, ought to know where the original corner was; this called out the old gentleman alluded to before, who affirmed that he knew where the corner was, and could have told the other surveyor if he would have let him; that he settled his land the next year after it was first surveyed, had driven the original post more firmly into the ground, and that four lengths of his foot and four inches from this oak stump and in range with that stump and his building would be found the old stake and two others. We dug where he marked, and found what the fraternity would call three stakes, although one was the place where a stake had decayed. The leaded stone was some 12 links north and west, enough north to leave the little creek on but one side of the line, and the south side at that. We measured the half mile north between 19 and 20, and in placing a monument for the corner on the east side of S. E. ¼, sec. 19, we found, it being wet ground, some two links from our corner, about 8 inches of the former stake. The line west left the little creek where it always was, both sides of the line, and us the best surveyor in the county.

In November of '81 we were requested by the Commissioner of Highways for the township of Walker, T. 7 N., R. 12 W., to mark the center of

a road, it having been laid out from the ¼ section stake between sections 9 and 16 north to the centre of section 9. It appears in this case that certain residents of section 16 had petitioned the board of supervisors, they had good reason to believe that some of their corners were lost, and they wished to have them *re-established* and perpetuated. The deputy before mentioned did the work. He claimed the corners for two miles were lost; measuring this distance he set at equal distances boulder stones with lead for corners. When he *established* the ¼ corner, as he called it between 9 and 16, the party, and Mrs. S., that owned the W. half of the S. E. ¼ of 9 being present, asked if she could set her fence west in accordance with that corner; he told her that she could and that the road was most all on her land. She moved the fence according to his instructions into the road. This was the road the Commissioner wished to find the centre of, which necessitated the finding of where that quarter section post was at the time the road was surveyed. During a few moments of talk we learned that the south half of the section had been subdivided when the original corner stakes were all standing, that a fence had been built on the line dividing the S. E. quarter into the east and west halves while the stakes set at time of subdivision were standing, that said fence was yet in place, that the S. E. corner of the section was well preserved. We found it, a stake with three quite large stones around it, the same in fact the other party, previously alluded to, started from. We measured from this corner west along the fence to the center of the subdivision or line fence running north between the east and the west half of the S. E. quarter, and from that line measured west a corresponding distance, where we placed a monument for the ¼ section post; twenty feet west of this point was a boulder with lead center. The ground at this place had been graded down some eight or ten feet for road purposes. A line from our stake north to the center of the section, established at time of subdivision, for center line of road placed the fence on west side of the road the same distance from the line that the owner of the land claimed he had set it at the time the road was surveyed. Mrs. S. had a suit with the town, was beaten and replaced her fence in its first position. We think there is not a member of this association who holds that even a county surveyor, much less a private citizen, can establish corners or conclude parties by their survey; or that measuring from one section corner to another and placing a monument equi-distant in the line from each, is *re-establishing* the quarter section stake; for their experience in the field will not warrant them in asserting that they always find it so in the original survey.

In the summer of '81 we were called in as it were for an opinion as to whether *A* should commence a suit of ejectment against *B* for a strip of land which *A* claimed his by right. It was the N. E. ¼ of the section. *A.'s* deed called for the E. half of N. E. ¼, and *B.'s* deed called for the W. half N. E. ¼, both according to government survey. We measured the N. half mile and found it 41.50 chains in length and the line fence about 0.75 chains east of the center of the half mile. We found the south half mile and line fence nearly the same, a very good cause for a law suit. On close investigation we found that when the parties who took up the quarter

section wished to build their line fence, thinking a "government half mile" the same length as any other half mile, commenced at the section corner and measured W. 80 rods, set a stake, also from the ¼ section stake they measured W. 80 rods, set a stake, and built their line fence from one stake to the other, each taking and maintaining his half. Our opinion was he could not get possession of the land by a suit at law.

It is sometimes necessary for us to make a survey which will be used as evidence in a law suit; as is usually the case there are two parties interested in a suit each of whom calls a surveyor. There is no general rule for such cases, and we quite frequently not only have to make the rule, but make the rule that makes it. We should not clothe ourselves with authority by inferences drawn from consulting the statutes of this state, disregarding all evidences of claim, previous occupation, and lines acquiesced in by the parties concerned. It is very generally held that when there has been a difficulty in fixing lines between proprietors, and they have agreed upon a certain boundary as the true one and have occupied, with visible monuments, it shall hold good and must not be disturbed, though not of sufficient time to acquire title by adverse possession. If you find the difficulty arises from a missing interior section corner and the appearance of the ground is such that would justify in thinking that digging would be of no use, hold a secret meeting, elect yourself judge with the privilege of asking questions, keeping the "ermine" well under your coat, "for in case of disputed lines unless the parties concerned settle the controvery by agreement, the determination of it is necessarily a judicial act and it must proceed upon evidence," [*Cooley*] and whisper to yourself this little couplet,

"Wherefore I will take what they say in spirit and in letter;
Mankind should be like rivers, free, the less they're dammed the better."

Then proceed to ascertain if any one ever saw the stake, how long since the stake was seen, if a bearing tree was ever seen, if any of the lines closing on this corner cross a stream near, whether its position has been changed, if any one knew the measured distance between stream and stake, if any fence was built or other improvement made with reference to stake, or any corner assumed or agreed upon; for, speaking of surveyors, Justice Cooley says, "He is to search for original monuments or for the places where they were originally located and allow them to control if he finds them, unless he has reason to believe that agreements of the parties expressed or implied have rendered them unimportant." Ascertain if any one has record of the length by subsequent measurement of either of the half miles closing here,—as a measurement and alignment of each of the half miles according to government survey and distance, if the four quarter section stakes were standing where originally located, thereby fixing a point, would not justify the surveyor in stating under oath that it was where the original monument was located—if any highway record would help to the solving of the difficulty, and thus proceed, for from such data he must locate.

Adopt a system of keeping notes at once full and readily understood

by yourself and be sure your contract is for as much *per diem attending court as for work in the field;* keep in your notes data for reasons and conclusions as well as the conclusions you arrive at. Equally important is the bearing of the surveyor on the witness stand; show no uneasiness or nervousness; have your evidence arranged in such a manner that no matter at what point counsel commence you are ready; if before a jury be sure in explaining your map that you have north north, for as a general rule no other class but surveyors can have north wherever the top of the map may be; use plain language and be sure to use such terms in explanation as they readily understand. If such survey is to be made for all parties interested, it would be better to proceed more on the principle of "Me and Bettie Killed the Bear" or virtually the parties themselves are doing this, than with the impression that you alone are dictating and ordering all things, for all parties in interest *must be satisfied;* for if the surveyor at the wishes and under the direction of all the parties in interest establish their boundary lines and make proper record of the same it will hold good.

There is very much more we would have said in this connection, but for the reason it has been so much better told in two former papers, one "ABOUT CORNERS," by Mr. Hodgman, the valuable information in which article would require years of hard labor in the field to obtain, the other NECESSARY INSTRUMENTS FOR SURVEYORS, by Prof. J. B. Davis. This is a casket filled with rare gems for the beginner. If in this disjointed ramble we have awakened an inquiry in the mind of the beginner and provoked a discussion among members we have accomplished an object.

RANDOM REMARKS ON THE MAINTENANCE OF WAY.

By E. TREADWELL, C. E., Assistant Engineer, F. & P. M. R. R.

One who has given any careful attention to or had any experience in the maintenance of way will generally come very soon to the conclusion that trackwork with the general public is a very dull subject. We sometimes hear the question: "What do trackmen find to do?" brought up among passengers and very briefly discussed; their attention having been called to it by seeing a larger gang than usual in one place at some special work. The almost invariable conclusion in such cases is, that most track men are lazy men, that they have plenty of leisure time, and never hurt their backs.

Now, to give all an opportunity of judging of the amount of leisure time the average trackman has, let us take a kind of birds' eye view of what has to be done in this state in one year. Let us suppose for a moment for our own convenience that for the coming season the maintenance of way of all the track in Michigan is to be under charge of one person, and that he has been given a memorandum of what he is to do. [And there are three or four of the larger corporations who own or control a mileage equal or very near to this.] A few extracts from his memoranda would read as follows:

1. You will have 5,146 miles of main track, 1,603 miles of sidings, 45½ miles, or in number 1,806 bridges, 6,983 culverts, 7,592 cattle guards, 5,039 highway crossings, 6,619 miles of fence and over 9,000 switches and frogs to look after.

2. You will have a regular working force of about 4,300 section men, 200 track carpenters and from sixteen to twenty work trains and crews.

3. It is the first duty of trackmen, when convened in the spring, to see that the track is properly tied; you will therefore, between now and May 1, buy 2,100,000 ties, get all the oak you can and make up the balance from the best of the soft woods. It will take 14,000 cars to load and distribute these ties; therefore if business is at all brisk, you had better commence at once to figure with the trainmaster for flats and get the distribution started. Leave the oak upon the curves, at highway crossings and points where there is most strain upon the rails. Commence to put these in as soon as frost is out of the roadbed and get them all in by September 15. Be sure you take out no old ones that will last another year or the new ones will not hold out and you would have to put old ones back. Pick up about one half of the best of the old ones to fill up sink holes, marshes and low places where you wish to make yard room and cover with earth. The balance pile up and burn.

4. You will have to lay, in repairs of rails, 47,000 tons of iron and steel, or 535 miles. This will take 3,130 cars to distribute. Pick up all the old rails you take out, sort carefully, keep the best for spurs and sidings, load or pile in convenient places to load the balance for scrap.

5. You will have to renew 71 bridges, 582 culverts, 852 cattle guards, and rebuild 550 miles of fence; for this you will require 5,000,000 feet of timber—and 7,500,000 feet of fencing and 363,000 fence posts; this will require 1,980 cars.

6. Nine hundred miles of main track and 200 miles of sidings should be lifted, put in surface and good line; for this you will require not less than 175,000 cars of ballast.

7. As soon as snow is off, burn all the old grass both sides of the track to keep fire from spreading. In June, July and August, cut all the weeds that grow up through the ballast; this must be gone over twice and much of it three times. Switches and highway crossings must be looked after every day, and during muddy weather or bad snow storms will need almost constant attendance.

8. Many other important matters, such as tightening of bolts and spikes, keeping track in proper gauge, lining of track and giving the proper elevation to curves; grading and laying new sidings, loading wood, shoveling snow, repairs of tools, inspection of bridges and culverts, and others too numerous to mention must have careful attention.

9. There are 5,000 miles of ditches that need cleaning out; much of this should be made both wider and deeper; put all your spare time in on this and do all you can.

10. The amount of new material you will have to use in the track, including the ballast, would load a continuous train of cars 1,220 miles long, and the old material to be picked up would load another train over eighty miles long.

Have all this done so as not to interfere with any regular trains even though, in many cases, it will take from one and one-half to three times as long as if you had a clear field.

Your men are expected to be ready on call at any hour for any emergency, in fact must be prepared for a dozen or more at the same time. High water, snow blockades, fires or wrecks seldom occur at convenient times or in handy places.

11. To pay for the above labor and material you will require six and one-half million dollars.

The above is a very brief outline of the work that, in one year, has to be done in the maintenance of way in this state, where less than fifty years ago not a single mile was in operation; and fifteen years ago but one-third of the present mileage.

The history of railroads in America is a short one, but a very thick one, its progress in every department most wonderfully rapid. When Americans once start out in any branch of industry to take the lead they do not like to be left behind. In the building of locomotives, coaches and cars, and for the rapid building of railway lines Americans stand at the head, but for the building of permanent way one cannot say as much;

there is so much that is temporary about American roadbeds that we may say, "Americans have scarcely begun to build permanent way, further than to secure the right of way, this they have solid." Most railroad companies have put much capital and energy into the construction of new lines to get possession of new territory, and doing this hurriedly have not put the care or expense upon its first construction or following repairs that true economy would seem to require. In many cases in order to make a small capital extend the iron as far over the prairie or into the woods as possible, engineers have been obliged to adopt steeper grades, run sharper curves and shorter tangents than they could recommend; take out narrow cuts, leave them without slopes and poorly drained, make narrow banks and haul little or no ballast when their best judgment would be that for every dollar saved in construction, inside of three years three dollars would be added to repairs. Between a poor foundation for a one-story saloon and a good foundation for a three-story State Capitol, there is a wide difference; there is an equal difference in roadbeds. A good roadbed is of the first importance to one in charge of its repairs for upon this depends almost the very nature of his work, the arrangement of the details, the number and kind of tools, and, to a great extent, the class of men employed.

The signs of the times indicate that we may look for great improvements in track and road-beds, gradually at first but rapid after a few years. The stronger companies when they get through building new lines will give more attention to old lines and where a dollar spent in improvement will save ten per cent. in repairs the improvement will be made.

To illustrate in a graphical way one point of progress that has been made and can be expected I have drawn three figures, cross sections of an ordinary troublesome clay cut in which seams of sand or gravel have allowed the water to filter through and keep the road bed wet or moist.

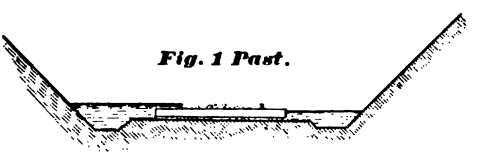
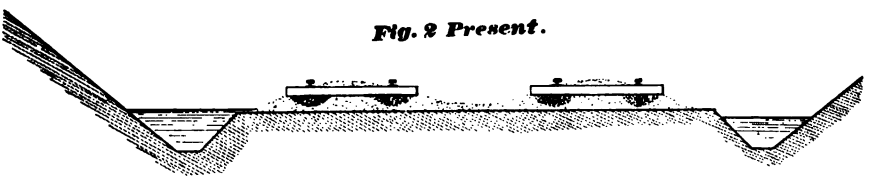


Fig. 1 Past.

Fig. 1 shows a cross section during the first rain storm after the iron was laid twenty-five years ago. You see the water has come to a stand-still about even with the top of the rail and is a little undecided as to whether it had best lift up the track or not and float it over against the slope. It really makes but little difference with the water, as it has full possession any way of the cut. The water has an old grudge against the section foreman and is now going to work it out. The water wishes to heave the track over against the slope, but is in no hurry about the matter, and as it is inclined to be economical with its own strength concludes to make the section men and train do most of the work. The first train that comes along puts the track through the thin layer of ballast and about two

inches into the mud, the second pushes some of it nearly out of sight, and the third sends it clear under. The average track man is very fond of water, but many of them will swear like pirates in cases of this kind; they never use it to thin their road bed. The section foreman and his five men work for a week to get the track up out of the mud and support it on blocks, stone, cord wood, and anything they can find. The mud begins to dry in places and section men commence to remove the blocking; but it can rain again just as easily as it did before and the first train over will slide the old track half way over to the slope; repeating this once or twice it is easy to get the track over to the slope and use but little water. The section men and trains have done all the work, the water bossed the job. All the other cuts and much of the bank are in about the same condition; one-third of the iron will have to be gone over with a rail bender before it is safe to run a train over fifteen miles an hour. The section foreman will have to take on two extra men to help him get his track back where it was and take his boy out of school to flag trains and carry water. Late in the fall very near the same thing will be repeated, only this time the water washes the track against the other slope to freeze it up there for the winter.

Fig. 2 Present.



In Fig. 2 it shows that business has picked up, a double track had to be made; the work train has taken out the cut wide enough for the foreman to get a good ditch 2 feet deep each side, also hauled in ballast to get 12 inches under the tie. The water cannot get within 20 inches of the top of rail, but it can filter through the bottom of the ballast and keep it all moist, and top of road bed soft and spongy.

The foreman has no use now for his old blocks and cord wood, but has to keep a small supply of shims on hand in frosty weather, and finds his track in the spring within 2 or 3 inches of where he put it in the fall. This is so far ahead of Fig. 1 that we will call it a good track now. In Fig. 3 business has increased still more, the trains become so numerous that it was difficult for the section men to take out a string of a dozen or more rails without danger of delay to some trains; also the bridge men had great difficulty in any repairs or adjusting. Work trains could make but little headway, and in case either track became blocked by accident there was great confusion. Then, to make sure of two tracks always in running order the third track was made and given over to the track department where they could work for a whole week without interruption from trains. The transportation department will take it Sunday morning and turn over one of the others to the track department for the next week,

and in this way the tracks are kept in better order, less danger of accident, and with about two-thirds the expense for track repairs. More ballast has been hauled. No water is wanted in or upon the road bed except what falls on top, and this runs away rapidly.

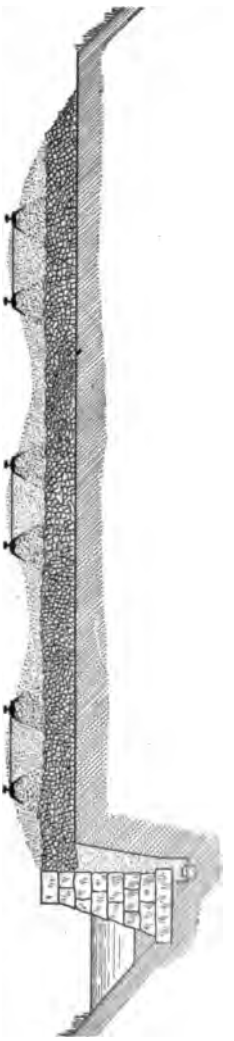


Fig. 3 Future.

Also, I might say that a cross section for a bank, a chart showing the variation of the two rails from a level, an accurate gauge, on a true line, would show an equal improvement; also, a map of its alignment with a profile of its grades would be greatly changed; switches and frogs, the cross section of the rail, its weight and length; the fastenings for the joints, have all changed many times. The section man who was an expert at track repairs thirty years ago, had he quit then and laid aside his best tools, would, if he were to pick up his old occupation again to-day, find that it was not the same; he might use his old pick and shovel, but his other tools would be so far out of date that he would lay them aside. The road was said to be constructed when Fig. 1 shows its condition; the changes since come under the head of maintenance of way.

The track department must be able to anticipate the wants and necessities of the transportation department, and the latter must provide for traffic that is increasing in both freight and passengers every year as population increases. So is the proportion of people increasing who want their freight moved quicker and want to travel faster. Time is becoming more and more an element of value. Railroad companies take pride in being able to say that their trains run fast and are always on time. Where, formerly, people, to know when the train was coming, would listen to hear the whistle, now look to the time card and the watch; less noise and better time are each a point of progress. Minutes at sixty miles an hour may be of more value than hours at twenty. Road beds that were constructed to carry twenty to twenty-five miles an hour must be improved to carry forty to sixty and even more, and this with a factor of safety. Wooden bridges must be replaced with iron and stone, wooden culverts and cattle guards with something more durable. Many culverts constructed thirty years ago in the woods and swamps are too small now; then the logs and brush, swamps and bogs would hold the

water back three or four days; now the woods and logs have been cleaned up, the swamps drained, and the water gets to the railroad bank in as many hours. The culvert is not large enough, there is danger of a washout, the pond of water against the bank softens it up and makes a bad roadbed. Every point where our present road bed is defective must be searched out and made more secure; places where to-day we may find track in first-class shape, to-morrow may be heaved 1½ to 2 inches out of level, and within a car's length as much in the opposite way; the time card is to be made sixty miles an hour over those places and they must be fixed. More ballast, or better drainage, or both may be wanted. Drain so that the water will be kept a sufficient depth below the ballast to insure always a *dry and firm* bed. If four feet is not enough, go six. If the water runs under from the side hill cut it off with a tile drain or a stone wall, or both, if necessary; let no water get to the road bed, over it, under it, or against it, except what falls upon it from above, and give this a free passage out of harm's way.

Less than twenty years ago 2,100 ties per mile was called a standard, later, 2,640 became the rule, now upon most trunk lines we find 3,000 or over. Laid 3,000 per mile they furnish a bearing under but little over one-third of the rail, or we might say they make a mile of track into a bridge supported by 3,000 independent bents which have for a foundation from 3″ to 15″ of ballast, which may be resting upon dry clay, wet clay, sand, gravel, loam, or rock. Often inside a train's length we may find several kinds of material, some of which will hold water almost as well as an iron kettle while others will let it off rapidly, and thus this foundation will change in stability with every change in the weather, but not equally.

It is difficult to get section men to tamp ties evenly. Unless more than ordinary care has been used in sorting, we may find some thick and some thin mixed, then the frost will come from under the thin ones first; or we may find a very narrow one between two very wide ones, then the narrow one will sink farther into the ballast with every wheel that passes over till it becomes loose. Tamping the wide ones loosely and the narrow ones firmly will hold but a few days, then it must be repeated. We may find hard wood and soft wood mixed. Then every wheel with a heavy load will crush into the soft wood while the hard wood will hold, and the soft tie is soon crushed so that every wheel with a light load will be supported by the two hard wood ties on either side, as the rail will not deflect to take a bearing in the crushed rail seat upon the soft wood unless heavily loaded or bent; spikes will also pull from the soft wood first or be pushed back so that the rails will spread and thus the gauge be made very irregular. The ballast may be heaved by the frost to give a bearing under the center of the tie and take it off one or both ends; then the tie will rock or break. The ballast may be thin and top of road bed rough, caused by letting teams and wagons upon it before the iron was laid or from having to lift the ties out of the mud before sufficient ballast was put on. Any of these defects will give an uneven support to the ties and an irregular motion to a train.

With all the little difficulties we may have in keeping up good track

with wooden ties, they have many good points, and it would be more difficult to do without; we shall have to use them as long as timber can be had from which they can be made. To place them in the track to get their longest and best service is a matter that will bear much careful study and discussion. Whatever we can do to prolong their service by treatment before they are put in, or by proper care afterward, is becoming of more and more importance every season as the source of supply decreases, the number used increases, the distance they have to be hauled increases and price becomes higher.

Taking 400 as the number per mile used every year for repairs (and this is a low figure), the United States, with the present mileage, use over 48,000,000, and this would load a continuous train over 1,500 miles in length. With this enormous quantity taken every year and nothing being done to maintain the source of supply, must we not expect that the price will increase to such an extent that iron or steel will soon begin to find a place either as a rolled tie or stringer upon the main track of important through lines, where a fast and heavy traffic must be provided for and a perfect track maintained at all times?

Rail makers are, if we may take their word for it, striving to turn out a rail that is uniform in grade and texture from end to end and that shall have all the elements of a first-class rail. To put this down so it will wear out evenly and not break, to carry a train safely, smoothly and rapidly, it must be in accurate gauge, in true line, and rest upon a uniform and firm foundation. With iron ties or stringers more accurate work could be done. A continuous bearing would seem to be very desirable. A rolled iron or steel stringer, placed with the concave side down, and breaking joints with the rail, giving the rail a continuous and a uniform support, with a supported joint, and track held in gauge by tie rods that could be adjusted to the exact gauge, would seem to have many good points. Such a stringer, placed and bedded firmly in a clean bed of fine ballast of even thickness, and under this an even amount of 1½ to 2 feet of broken stone or burned clay, resting upon a road bed that is thoroughly drained, would furnish a support to a rail that we could expect would reduce the number of loose joints and broken rails, carry a heavier load, and at a greater speed than the average good track of the present day.

We must keep in mind that every year first-class track is to be examined with a more critical eye, that its standard is to be raised, that twenty-five years hence first-class track will be far different from that of to-day. Speed and safety must be secured to the public. The transportation department must have a track that is reliable from end to end, at any hour of the day or night, for a fast or heavy train. The managers must have a track upon which the wear and tear to both rolling stock and track is a minimum, over which they can keep a reputation for speed, safety and comfort, with a semi-annual dividend.

THE LOCATION OF THE WESTERN DIVISION OF THE CANADIAN PACIFIC RAILWAY.

BY FRANK P. DAVIS.

The Canadian Pacific Railway was originally projected as a government enterprise in the year 1871, in pursuance of an agreement made with the Province of British Columbia, when it became a part of the Dominion of Canada. It was intended to give an all rail route from ocean to ocean entirely within the British provinces. Sandford Fleming, C. E., was appointed engineer-in-chief for the government, and immediately put a number of parties in the field to make the necessary explorations and surveys to determine the most desirable location for the road. The magnitude of the work will be in some measure realized when we consider that there was an uninhabited and almost unknown region 2,500 miles in length with a breadth of 350 miles to be thoroughly explored. Unknown mountain passes many hundred miles from the base of supplies were to be sought out and surveyed, in regions where the winters are long and rigorous, with so heavy a fall of snow that travel, except with snow shoes and dog trains is an impossibility,—while in the summer there are long distances entirely destitute of water. On the plains wood frequently had to be hauled from fifty to one hundred miles, where the best transportation to be had was the Red River cart, drawn by one small pony. In many portions of the mountain regions the only transportation for supplies and camp equipage was by packing on the backs of men.

After several years of preliminary work a line was adopted passing a little to the north of Winnipeg, Manitoba, and pursuing a northwesterly direction about two hundred miles, then turning nearly due west to the valley of the North Saskatchewan river, the drainage of which it followed in a nearly westerly direction to the foot hills of the Rocky Mountains, where it crossed a line divide to the Athabaska river, which it ascended in a south-westerly direction to the continental divide at Yellow Head Pass, about ten hundred and twenty-seven miles from Winnipeg, in latitude about 52° 50′ north, longitude 118° 45′ west from Greenwich, attaining an elevation at this point of 3,646 feet above sea level. From here it descended, still keeping a general westerly course, to Tête Jaune Cache, about fifty miles from the summit, where it turned nearly due south into the head waters of the Thompson and Fraser rivers, which it followed to the Pacific at Port Moody, on the Gulf of Georgia, just north of the boundary line between the United States and British Columbia, at a distance of fifteen hundred and twenty miles from Winnipeg.

The maximum grade on this line is fifty-two and eight-tenths feet per mile, which was only secured by a great deal of excessively heavy work. The sharpest curve was six degrees (radius 955 feet). About nine hundred and seventy-five miles of this line was across the great plains stretching from Winnipeg to the Rocky Mountains, and five hundred and forty-five in a rugged mountain region.

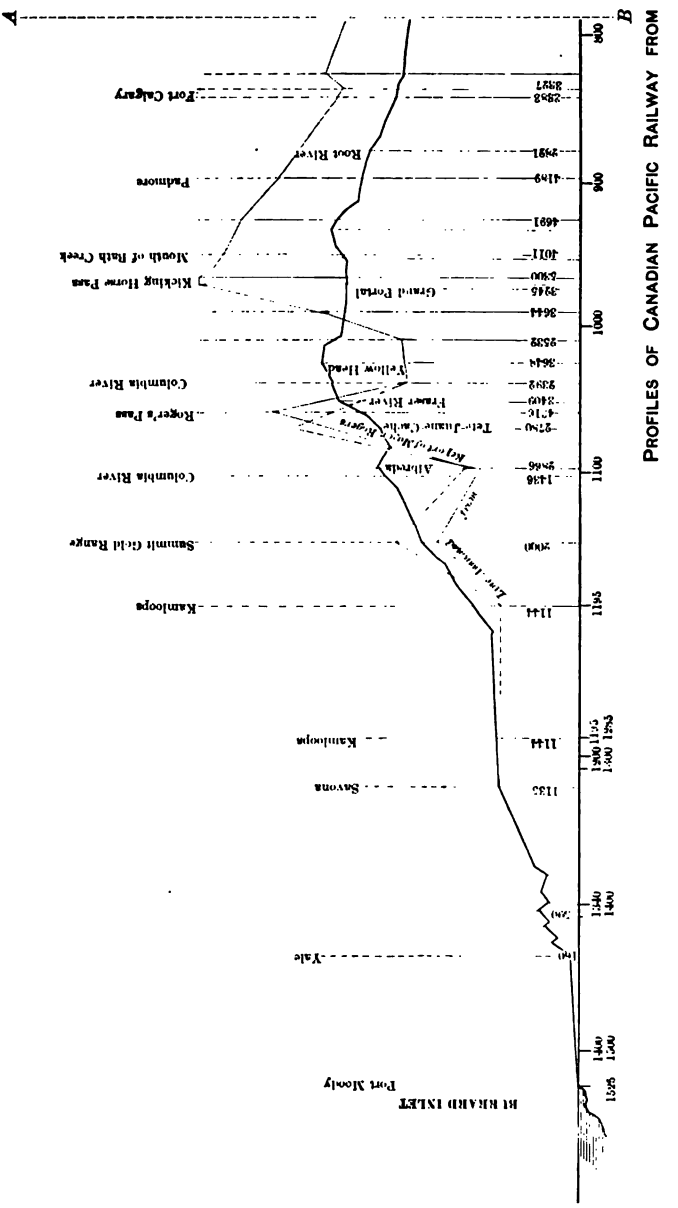
There was considerable work done on this line, when in the year 1880 the government, finding the cost more than they had anticipated, made arrangements with a syndicate to take the road off their hands and complete it.

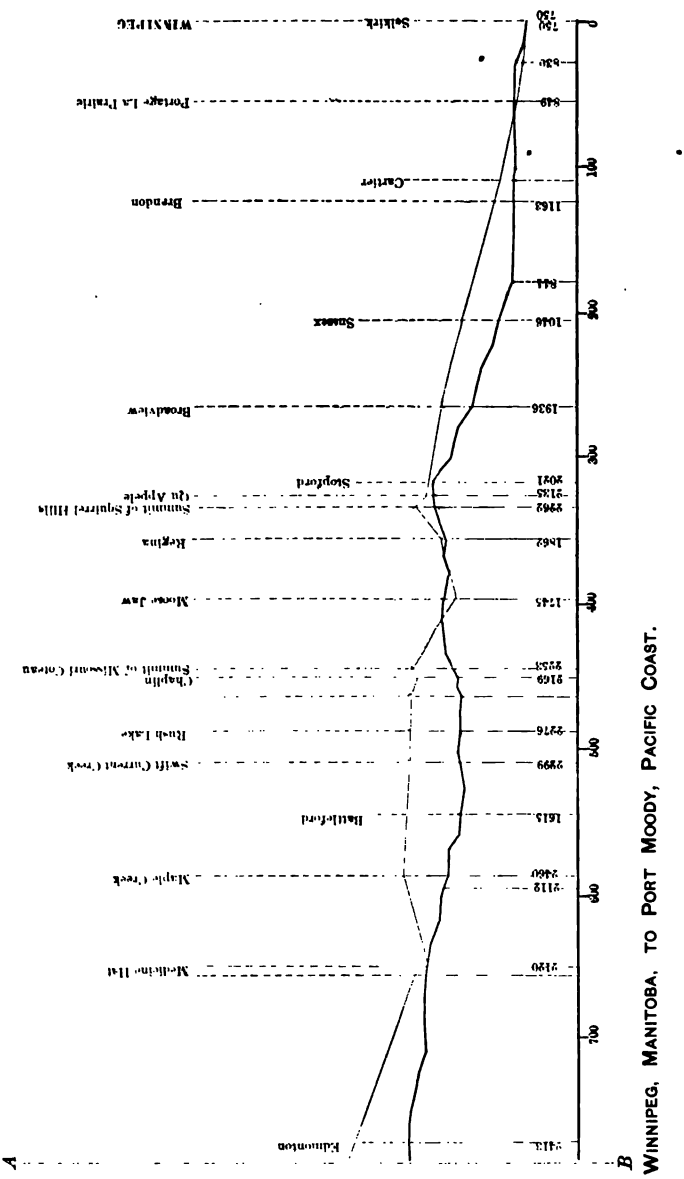
The line as located by Sandford Fleming was remarkable not only for the low summit and easy grades obtained, but for making only one summit in crossing the numerous ranges that make up the Rocky Mountain system. An examination of a map of the country will show that any line to the south of Yellow Head Pass must make at least two summits in crossing the mountains, while to cross anywhere south of the fifty-second parallel of latitude at least three summits must be overcome, viz.: the Rocky Mountains, the Selkirk range, which lies in the long loop of the Columbia river, and the Gold range, which lies between the west arm of the Columbia river and the Pacific ocean.

When the syndicate assumed control of the road, General T. W. Rosser was appointed chief engineer and it was at once decided to abandon the Yellow Head route, and notwithstanding the greater difficulties to be overcome, to adopt a more southerly and shorter line. The wisdom of this change will be discussed later. Major A. B. Rogers was put in charge of the Mountain division, and in the spring of 1881 proceeded with five parties to make the necessary explorations and surveys to decide upon what pass should be adopted in crossing the Rocky and Selkirk ranges. Major Rogers spent most of his time in exploring, but for some reason so little was accomplished by the five parties that at the end of the season they returned without having demonstrated that there was a practicable route to be found. In the mean time there was completed from Winnipeg westward one hundred and five miles of road.

Early in the year 1882 a contract was entered into with Langdon, Shepard & Co., of St. Paul, Minn., to construct and turn over to the syndicate, in complete running order, five hundred miles of road in one year. This rendered it absolutely necessary that the location across the mountains should be settled that season. It was decided to attempt a location over the Rocky Mountains by following up the Bow river and its tributaries to the Kicking Horse pass in about 51° 20′ north latitude, and 116° 45′ west longitude, and following down the Kicking Horse river to the Columbia river on the west.

About the first of April, 1882, Major Rogers started for the Pacific coast to explore the Selkirk range, leaving Major M. F. Hand in charge of the locations in the Bow and Kicking Horse valleys. Major Hand, with two parties, arrived at the Kicking Horse summit, June 20. At this late date there was much snow in the mountains, and two parties going through to the Columbia river to join Major Rogers were seriously


A
B
Fort Calgary
Root River
Padmore
Mouth of Bath Creek
Kicking Horse Pass
Yellow Head
Columbia River
Roger's Pass
Fraser River
Tête-Jaune Cache
Albreda
Columbia River
Summit (Gold Range
Kamloops
Kamloops
Savona
Yale
Port Moody
BURRARD INLET
Grand Forks
Lytton
Boston Bar
Mission
Agassiz
Westminster Junction
Vancouver
PROFILES OF CANADIAN PACIFIC RAILWAY FROM


WINNIPEG, MANITOBA, TO PORT MOODY, PACIFIC COAST.
A
B
Kilometres
0
100
200
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500
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Winnipeg
Selkirk
Portage La Prairie
Carter
Brandon
Sussex
Broadview
Stopford
Summit of Squirrel Hills
Qu'Appelle
Regina
Moose Jaw
Chaplin
Summit of Missouri Coteau
Rush Lake
Swift Current Creek
Maple Creek
Medicine Hat
Bowell
Kamloops
150
650
849
1163
844
1046
1936
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2135
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1662
1245
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delayed by drifts on the western slope. About this time General Rosser resigned and Mr. J. C. James was appointed chief engineer of the road.

The whole mountain region was densely wooded, so that no definite idea could be formed by once travelling over it, and as no preliminaries had been run, nothing was known as to what grade could be obtained. After spending a few days in making examinations with an aneroid barometer, which in this climate was wonderfully unreliable, it was decided that one party, in charge of Mr. H. S. Hewson, should run a preliminary down the Kicking Horse valley (or more properly cañon), using a grade of 2 feet per 100 (105.6 feet per mile) until this grade would catch the bottom of the valley; while the other party, in charge of the writer, was to begin a location eastward, using a maximum grade of 1.42 feet per 100 (75 feet per mile) reduced for curvature at the rate of 0.05 foot per degree of curvature per 100 feet. This line followed Summit Brook about one mile, to Bath Creek, which in turn was followed about four miles to Bow river, in the valley of which the line kept to Fort Calgary, about one hundred and twenty miles. After reaching Bow river a grade of 40 feet per mile was found to be sufficient and no steeper grade was used. An examination of the map and profile showed that in the first five miles from the summit a great saving in cost of construction could be effected and a large amount of curvature thrown out by using a grade of about one hundred feet per mile for one mile and getting into the bottom of Bath Creek, then using a grade of seventy feet per mile to Bow river, about four miles. This line was finally adopted.

Going west from the summit there are three small lakes in a distance of about three miles, which are the source of the Kicking Horse river, and the valley is nearly level. At this point the water pours over the rocky rim of the valley and falls at the rate of 400 feet to 500 feet per mile for a long distance, necessitating a supported line high on an unusually precipitous mountain slope. The preliminary with a 2 per cent. grade showed that, at a distance of eight miles from the summit, grade would be at least 800 feet above the river, and that bottom could not be reached in less than twenty miles. It was finally decided to use a grade of 116 feet per mile, with grades reduced for curvature at the rate of 0.05 feet per degree per station.

On the western slope there were eight miles of location made during the summer of 1882. From the summit east the line was located to the base of the mountains at Padmore, sixty-five and $\frac{6}{10}$ miles. Major Rogers, with two parties, respectively, in charge of Messrs. D. McMillan and F. W. Aylmer had spent the season in running some preliminaries in the lower Kicking Horse, cutting trails and exploring the Selkirk range, where he was successful in discovering the long-hoped-for pass, which, in recognition of his services, was christened Rogers' Pass. In the meantime, Mr. J. H. Secretan, engineer in charge of location on the plains, had pushed his location westward to a point about thirty miles west of the crossing of the Saskatchewan river at Medicine Hat, or seven hundred miles west from Winnipeg.

The discovery of Rogers' Pass definitely settled the location from the

Kicking Horse summit westward, the route being substantially as follows: Down the Kicking Horse to the Columbia, down the Columbia, to the north, about thirty miles, to the mouth of the Beaver, which it ascends in south-westerly direction to Rogers' Pass, thence descending Moberly Creek in a north-westerly direction to the second crossing of the Columbia river, thence ascending Eagle Creek in a south-westerly direction to Shuswap Lake, thence nearly west to Kamloops, where the line as located by Sandford Fleming is struck.

Before the opening of the working season in 1883, Mr. J. C. James, the chief engineer, died, and a contract was entered into with the North American Contracting Company to complete the road. Mr. James Ross was appointed manager of construction for the contracting company and assumed control of the engineering. It was decided to reduce the grade from the crossing of the Saskatchewan river from 52.8 feet per mile to 40 feet to agree with the grade already used in ascending the eastern slope of the mountains.

In the upper Kicking Horse valley the problem was to reach the bottom as quickly as possible; accordingly Mr. L. M. Davis, who had charge of this work, used a continuous grade of 116 feet per mile for eighteen miles. On this portion of the line there are two tunnels, one about 300 feet in length and one 1,800 feet. The cost per mile for this distance will exceed $100,000. The next five miles is a bottom line and comparatively easy. From this point 26.3 miles west of the summit to the Columbia river, a distance of 18.4 miles, there were three locations made. The first, by D. McMillan, used a maximum grade of 52.8 feet per mile and kept from 100 feet to 225 feet above the level of the river. Where it turned into the Columbia valley the grade was 220 feet above the river. In the next ten miles it crossed a large number of deep ravines, requiring a large amount of very expensive trestle work, one gully being 220 feet deep and 1,000 feet in width.

By using a grade of 66 feet per mile the Columbia flats could be reached at the mouth of Kicking Horse river and this expensive bridging avoided, and a great saving made in the earth-work on the first ten miles running down the Columbia. The writer was ordered to make such a location; but this line like McMillan's was utterly impracticable. While the average fall on this 18 miles was less than 66 feet per mile, it was not at all evenly distributed, at one point in a distance of two miles being 220 feet.

The only possible hope now lay in a line using a grade steep enough to follow the bed of the river and keep but a few feet above high water, which is only about eight feet above low water, crossing the river frequently and tunneling the points that were too sharp to turn with ten degree curves. As the fall for a long distance was almost exactly 116 feet per mile, allowing for curvature, and as this grade was used for 18 miles in the upper part of the valley, it was adopted for this portion of the line and a new location was made by L. M. Davis, working from the upper end, and the writer from the lower. This line proved to be practicable but very expensive. At one point in a distance of three miles there are five tunnels

with an aggregate length of 2,100 feet, and four crossings of the river, which has a width of from 200 feet to 250 feet, and must be crossed with a single span. This line, with some minor changes, was the one adopted for construction. The cost for the 45 miles from the Kicking Horse summit to the Columbia river will not fall much if any short of $100,000 per mile.

That portion of the line which is in the valley of the Columbia was in charge of Mr. J. L. Stevens, who secured an excellent line with a maximum grade of 40 feet per mile. From the Columbia river to the summit of the Selkirk range a maximum grade of 116 feet per mile was used and a very good line obtained with moderate work. This portion of the line was in charge of Messrs. J. L. Stevens and B. D. Critchelow. The sharpest curve allowed was ten degrees (radius 573.7 feet) and was frequently used on all the work west of Kicking Horse summit. On the eastern slope there is nothing sharper than eight degrees. From the summit of the Selkirk to the second crossing of the Columbia river there was a preliminary survey made during the summer of 1883 by D. McMillan, which fully demonstrated the practicability of that portion of the route. From this point to Kamloops, where the Yellow Head line will be reached, the distance is estimated at 95 miles, making a total of 1,195 miles as against 1,285 miles by the Yellow Head line. This 95 miles includes the crossing of the Gold range, and at the close of the working season of 1883 but little was known in regard to what grades could be obtained, but it was hoped that a maximum of 52.8 would be sufficient. It is known that there will be some of the heaviest work on the whole line in the neighborhood of Kamloops Lake.

The writer has been thus particular in regard to the history of this location that it might be fully understood that there was no general plan marked out in regard to the location. So far as the writer has been able to learn there never were any instructions in regard to the proper values to be assigned to saving of distance, curvature, rise and fall, or increase of maximum grades. Nor was the probable amount of traffic in the different directions taken into account in fixing the grades, but each engineer was left to evolve the necessary data to guide him in making a judicious location on his own particular piece of work. As might be expected, instead of a line, each portion of which had been designed with reference to the economical working of the whole, it is made up of a number of parts, each located entirely without any regard to the others. If it does not present glaring inconsistencies it is due to the nature of the country, rather than any careful forethought on the part of those having the matter in charge.

The value of any reduction in length of line, curvature, rise and fall, maximum grade, etc., has been discussed by others, but, to the writer's knowledge, the only method approaching anything like a thorough treatment is to be found in "The Economic Theory of the Location of Railways," by A. M. Wellington.

The portions of the tables necessary to make a fair discussion of the different lines are here copied from that book.

"TABLE A."

Showing the capitalized value per mile and per foot of saving short distances, not affecting the cost of train wages; assuming a total cost per train mile of $1.

Rate of interest on capital.....	5 %	6 %	7 %	8 %	10%	
VALUE OF ONE MILE.						Yearly cost of one additional mile.
For each estimated daily train (round trip) over the line.....	$5,460	$4,550	$3,900	$3,410	$2,730	$2.73
VALUE OF ONE FOOT.						Yearly cost of one additional foot.
For each estimated daily train (round trip) over the line.....	$1.03	$0.86	$0.74	$0.65	$0.52	$0.0517

REMARKS.—If the cost per train mile be higher or lower than $1, the value *per daily train* given above must be multiplied by that assumed cost. For any saving great enough to decrease the cost of all train wages per trip, the values given above must be increased by a maximum of 33 per cent., and for any considerable distances sufficient to increase the number of daily or yearly trips over the line, by a maximum of about 50 per cent.

"TABLE B."

Showing the capitalized value of saving one degree of curvature; for curves of moderate length and average radii, assuming a total cost per train mile of $1.

Rate of interest on capital.....	5 %	6 %	7 %	8 %	10 %	Yearly cost of 1° of curvature.
For each estimated daily train (round trip) over the line.....	$4.87	$4.06	$3.48	$3.05	$2.44	$0.244

REMARKS.—If the cost per train mile be higher or lower than $1 the value *per daily train* given above must be multiplied by that cost.

For sharp reversed curves, connected by tangents not sufficiently long for the train to straighten, then values should be increased by a maximum of 50 to 100 per cent., and for very short curves of long radii reduced in nearly equal proportions.

"TABLE C"

Showing the capitalized value of saving one foot of rise and fall on gradients over 40 feet per mile and not exceeding the ruling grade; assuming a total cost per train mile of $1.

Rate of interest on capital.....	5 %	6 %	7 %	8 %	10 %	Yearly cost of 1 ft. rise and fall.
For each estimated daily train (round trip) over the line.....	$41.60	$34.67	$29.71	$26.00	$20.80	$2.08

REMARKS.—These values are strictly correct only for gradients of about 50 feet per mile. To estimate the cost of rise and fall on other gradients with greater exactness the values given above should be corrected by the following percentages:

On 12½ feet per mile grades, 50 per cent. less than above.
On 25 feet per mile grades, 25 per cent. less than above.
On 35 feet per mile grades, 10 per cent. less than above.
On 80 feet per mile grades, 10 per cent. more than above.
On 125 feet per mile grades, 15 per cent. more than above.

TABLE D.

Showing the capitalized value per daily train of avoiding an addition of one foot to the ruling grade.
Tabulated for a road 100 miles in length. Reduce or increase in proportion to length of road or division.
Cost of train mile assumed at $1.

Rate of maximum grade in feet per mile	Level.	10	20	30	40	50	60	80	100	150
Percentage of increase in engine tonnage for each foot of increase in rate of grade	4.0	3.1	2.4	2.0	1.7	1.5	1.4	1.2	1.1	0.9
Cost per year of one foot increase in rate of grade = $312.00 × 100 miles × percentage in line above	$ 1,248.00	$ 967.20	$ 748.80	$ 624.00	$ 530.40	$ 468.00	$ 436.80	$ 374.40	$ 343.20	$ 280.80
Capitalized value,		24,960.00	19,344.00	14,976.00	12,480.00	10,608.00	9,360.00	8,736.00	7,488.00	6,864.00	5,616.00
Rate of interest 5%		20,800.00	16,120.00	12,480.00	10,400.00	8,840.00	7,800.00	7,280.00	6,240.00	5,720.00	4,680.00
" " " 6%		17,830.00	13,817.00	10,697.00	8,914.00	7,577.00	6,686.00	6,240.00	5,349.00	4,903.00	4,011.00
" " " 7%		15,600.00	12,090.00	9,360.00	7,800.00	6,630.00	5,850.00	5,460.00	4,230.00	4,290.00	3,510.00
" " " 8%		12,480.00	9,672.00	7,488.00	6,240.00	5,304.00	4,680.00	4,368.00	3,744.00	3,432.00	2,808.00
Relative number of trains (or engine tonnage) required for same business	1.0	1.41	1.83	2.27	2.73	3.21	3.72	4.80	5.96	9.56
Relative net load per engine ton	1.0	0.711	0.546	0.440	0.365	0.311	0.269	0.208	0.168	0.105

REMARK.—For *very considerable* changes in the rate of grade the following corrections should be made for strict accuracy:

For a change in rate of grade of	The percentage above should be increased about
40 feet per mile.	8 per cent.
50 feet per mile.	10 per cent.
60 feet per mile.	12 per cent.

REMARKS.—If the cost per train mile be higher or lower than $1, multiply the values above by the actual or assumed cost. Multiply also by the length of the road ÷ 100; and by the number of feet per mile in the proposed change of rate.

For an original rate of grade intermediate between those given in the table, the proper tabular value will be given, very nearly, by proportional interpolation.

The above tables are believed to give a closer approximation to the true values than the methods usually given, and the error, if any, will be on the safe side; That is, the values given are less than those usually employed.

An approximate comparison of the values of the two lines can now be made.

The elevation above the sea of the principal points on the two lines according to the latest information of the writer is as follows:

YELLOW HEAD LINE.

Winnipeg	737 feet.
Yellow Head Summit	3646 feet.
Kamloops	1144 feet.

KICKING HORSE LINE.

Winnipeg	737 feet.
Kicking Horse Summit	5300 feet.
First crossing of Columbia river	2392 feet.
Rogers' Pass	4316 feet.
Second Crossing of Columbia river	1436 feet.
Summit Gold Range	1927 feet.
Kamloops	1144 feet.

As the first 965 miles of both lines were through the same character of country, that portion of both lines will be dropped in making the comparison, except that the extra elevations of the Kicking Horse Summit above the Yellow Head Pass will be considered. The curvature on the balance of the lines, viz.: 230 miles on the Kicking Horse and 320 miles on the Yellow Head will be taken at 200° per mile, which is a fair average as shown by the actual location in the Kicking Horse Valley.

We have then the following data:

	Kicking Horse.	Yellow Head.
Distance Winnipeg to Kamloops	1,195 miles.	1,285 miles.
Rise and fall	6,865 feet.	2,705 feet.
Curvature west of 965 miles	46,000 degrees.	64,000 degrees.
Maximum grade	116 feet.	53 feet.

In making a comparison of these lines the cost per train mile will be taken at $1.75 and interest at 6 per cent.

Three trains are assumed to run daily each way over the road, fully

loaded for a maximum grade of 52.8 feet per mile, which, judging from other western roads, is as high an estimate as can safely be put upon it for some time. As the trains are made up for a grade of 52.8 feet per mile it will be necessary to determine the proportionate engine tonnage necessary to handle the same net load on a grade of 116 feet per mile.

The total resistance of a train can be separated into two parts, one of which, that due to gravity, varies directly as the grade and

$$= \left(\frac{\text{Grade in feet per mile} \times 2000}{5280}\right) \text{ gross weight of train;}$$

the other due to friction, is entirely independent of grade and has been found by experiment to vary from about 6 pounds per ton of gross weight of trains, as shown by Colburn's experiments on the Erie road, to 12 pounds per ton, as assumed by Benj. H. Latrobe in his report on the location of the Portland and Ogdensburgh railroad. Colburn's experiments were for slow speed and perfect roadbed and equipments, while 12 pounds per ton would be sufficient for a very poor track and equipment. As trains are usually made up in working a road, the motive power is generally about sufficient to overcome a resistance independent of gravity of nine pounds per ton, which value will be used in this paper. The total resistance due to both gravity and friction

$$= \left(\frac{\text{Grade in feet per mile} \times 2000}{5280} + 9\right) \text{ gross weight of engine and train.}$$

The adhesion of an engine has been shown by experiment to vary from $\frac{1}{3}$ to $\frac{1}{7}$ the weight on the drivers. An average of $\frac{1}{5}$ the weight on drivers is here used and is about the amount assumed in the ordinary working of a road.

Taking the standard freight engine of the Pennsylvania railroad which weighs with loaded tender 58 tons, with 24 tons on the drivers, the traction $= 24 \times 2000 \times \frac{1}{5} = 9600$ pounds.

The gross weight of trains on grade of 52.8 feet per mile

$$= \frac{9600}{\frac{52.8}{5280} \times 2000 + 9} = 331 \text{ tons.}$$

The net weight of train $= 331 - 58 = 273$ tons.

The gross weight of train on grade of 116 feet per mile

$$= \frac{9600}{\frac{116}{5280} \times 2000 + 9} = 181 \text{ tons.}$$

The net weight of train on 116 feet grade $= 181 - 58 = 123$ tons.

The engine tonnage on the 116 feet grade =

$$\frac{\text{Net weight on 52.8 feet grade}}{\text{Net weight on 116 feet grade}} = \frac{273 \text{ tons}}{123 \text{ tons}} = 2.21.$$

As the engine tonnage on the 116 feet grade will be 2.21 times that on the 52.8 grade, or in other words as there will be 2.21 times as many trains, it is evident that the value of curvature and rise and fall as given in the tables must be increased in this proportion. As the extra length occurs on the low grade line it should be estimated for three trains only.

The extra expense of an increase in the maximum grade consists entirely in the greater number of trains required to do a given business; therefore there will be no increase over that given by the tables.

IN FAVOR OF THE YELLOW HEAD LINE.

63 feet reduction in ruling grade for 110 miles; value (at 6 per cent). by Table D.

$\$7,644 \times \frac{110}{100} \times 63 \times 1.75 =$	$927,025	
Increase by 12 per cent. on account of extent of change	111,243	$1,038,268
4,160 feet less rise and fall. Value by table C.		
$4,160 \times \$34.67 \times 1.75 =$	$252,397	
Increase by 15 per cent. on account of great change in rate of grade	37,859	
	$290,256	
Increase by 121 per cent. on account of greater number of trains on steeper grade	$351,209	$641,465
*8,620 degrees less curvature. Value by table B.		
$8,620 \times \$4.06 \times 1.75 =$	$61,245	61,245
Total in favor of Yellow Head Line per daily train		$1,740,978

AGAINST YELLOW HEAD LINE.

90 miles increase in distance. Value by Table A.

$90 \times \$4,550 \times 1.75 =$	$716,625	
Increase by 40 per cent. on account of great change	$286,650	
Total per daily train against Yellow Head Line		$1,003,275
Difference per daily train in favor of Yellow Head Line		$737,703
For 3 daily trains		$2,213,109

This is on the supposition that the 50 miles crossing the Rocky Mountains and the 60 miles crossing the Selkirks are operated with assistant engines, and the 30 miles intervening with one engine. If the whole distance from the beginning of the steep grade to the western base of the Selkirk Range was operated as one division and trains made up for the 116 foot grades, and run clear through, the amount in favor of the Yellow Head line would be increased by $334,746 per daily train, or for three trains $1,004,238, giving a balance in favor of the Yellow Head line of $3,217,347. As it ought never to be operated in this way the former amount of $2,213,109 is considered to be the operating value of the line for three daily trains over the present location.

If there is any unfairness in these figures it is in favor of the Kicking Horse line; for it has been assumed that a grade of 52.8 feet per mile can

*The amount of curvature is arrived at as follows:
On the Yellow Head Line 320 miles × 200 degrees per mile = 64,000 degrees.
On the Kicking Horse Line 230 miles × 200° per mile = 46,000 degrees, but as on this line for 110 miles, the engine tonnage is 2.21 times that on the Yellow Head line, the curvature on this portion of the road must be increased by 121 per cent., giving as the necessary increase 110 × 200° × 1.21 = 26,620°; 46,000° + 26,620° = 72,600 from which deduct 64,000° leaving 8,620° in favor of the Yellow Head line. There is an apparent difference in favor of the Kicking Horse line of 18,000°, which becomes, when the number of trains rendered necessary by the steep grade is taken into account, 8,620° against that line, showing the fallacy of equating by simply considering the total number of degrees in each line, without regard to the grades with which the curvature is used, as is frequently done.

be obtained from the second crossing of the Columbia river to Kamloops, which in the writer's opinion is very doubtful. Also the distance from Winnipeg to the eastern base of the Rocky Mountains by the Kicking Horse line is 900 miles, while by the Yellow Head it is 965 miles, giving 65 miles more in an arable country. If the traffic between Winnipeg and the mountains yields any profit, and it must if the road pays running expenses, a certain amount ought to be added in favor of the Yellow Head line.

As shown above, the operating value of the Yellow Head line is (for three daily trains) $2,213,109 greater than the present location, but as there would have been 90 miles more to construct, if we consider the two lines to cost the same, mile for mile, the additional cost of construction would be, assuming $50,000 per mile as the average cost; 90 × $50,000 = $4,500,000, which should be offset against the $2,213,109 in favor of the Yellow Head line, leaving a balance in favor of the Kicking Horse route of $2,286,891 for three daily trains. Should the business of the road increase to seven daily trains the balance would be somewhat in favor of the Yellow Head line, as the operating value in favor of that line would be $737,703 × 7 = $5,163,921 against $4,500,000 extra cost of construction. If the cost per train mile on the number of trains be increased or diminished, the relative operating values of the lines will not be altered, but only the actual value in dollars and cents.

Some of the details of Kicking Horse line will next be examined.

From Winnipeg west for about 250 miles the maximum grade is 40 feet per mile, and for the next 410 miles 52.8 feet per mile (except a short piece getting west of the Saskatchewan river, which is 66 feet, and will be operated with an assistant engine when needed), which is followed by 305 miles with a maximum grade of 40 feet per mile.

Again assuming three daily trains at $1.75 per train mile with interest at 6 per cent., the value of reducing the maximum grade of 52.8 to a 40 foot grade is by Table D.

$$\$8{,}840 \times \frac{410}{100} \times 12.8 \times 3 = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\$1{,}391{,}769$$

As most of the way the grades are less than 40 feet per mile and the 52.8 feet is only used occasionally, it is apparent that it would have been economy to have used a 40 foot grade throughout. This of course is on the assumption that the trains are fully loaded for the 40 foot grade. Unless the grades have been changed since the original construction, there are curves on the maximum grade which would render it at least equivalent to a grade of 60 feet per mile on tangent, so the estimate is believed to be within bounds. The direction of greatest traffic on this portion of the road is yet so uncertain that it has been left altogether out of the account.

The 305 miles reaching from the Saskatchewan river to within five miles of the summit of the Rocky Mountains with a grade of 40 feet per mile has eight degree curves, with the grade reduced at the rate of 0.05 feet per degree per 100 feet. The next 140 miles reaching to the second

crossing of the Columbia river has grades in both directions of 116 feet per mile, with ten degree curves, the grades being reduced for curvature as above. This can be most economically operated in three sections: one of 50 miles extending to the Columbia Valley, which would be operated with assistant engines, one of thirty miles running down the valley of the Columbia with no grades exceeding forty feet per mile, operated with one engine, and a section of 60 miles crossing the Selkirks having grades of 116 feet per mile in both directions.

The traffic on this portion of the road will undoubtedly be much greater going west than returning, and will be assumed to be 3 tons paying freight going west to 2 tons going east, which is about the proportion on the Union Pacific railway. If the trains going west are fully loaded for a grade of 40 feet per mile, the gross weight would be, for an engine weighing 58 tons with 24 tons on drivers, 397 *tons, and a net weight of 397 tons — 58 tons = 339 tons. Assuming the weight of a car to be the same as its load the paying load going west would be $\frac{339}{2} = 169$ tons and the paying load east $169 \times \frac{2}{3} = 113$ tons. As the cars must all be returned the net load east would be 113 + 169 = 282 tons.

A maximum grade of 116 feet per mile was fixed by the government and ought if possible to have only been used against the lighter traffic. A grade to offer the same resistance to a train having a net load of 339 tons as the 116 feet grade does with a net load of 282 tons can be determined. The operation will be simplified by finding for the different grades the gross load per ton of traction. As heavier engines would undoubtedly be used on the steep mountain grades, a Mogul engine weighing with loaded tender about 60 tons, with 30 tons on drivers will be assumed. As one-half the engine and tender is on the drivers and the adhesion one-fifth the weight on drivers, the traction of the engine would be $\frac{1}{2} \times \frac{1}{5} = \frac{1}{10}$ the total weight of engine and tender, or the engine has a weight of 10 tons for each ton of traction. This is very nearly true for Mogul engines as constructed by any of the different makers.

For a grade of 116 feet per mile the gross load per ton of traction $= \frac{2000}{\frac{116}{5280} \times 2000 + 9} = 37.78$ tons; the net weight = 37.78 tons — 10 tons = 27.78 tons, and $\frac{\text{the net weight of train}}{\text{the net weight per ton of traction}} = \frac{282}{27.78} = 10.15$ tons, the required traction on the 116 foot grade. The grade up which an engine having a traction of 10.15 tons = 20,300 pounds will take a net load of 339 tons (the estimated load going west) is 98 †feet, and is the grade which

*Gross weight $= \frac{24 \text{ tons, or } 9{,}600 \text{ pounds}}{\frac{40}{5280} \times 2{,}000 + 9} = 397$ tons.

†An engine having a traction of 10.15 tons = 20,300 pounds weighs 101.5 tons, and the grade up which it will take a net load of 339 tons =

$$\frac{5280}{2000}\left(\frac{20300}{339 + 101.5} + 9\right) = 98 \text{ feet.}$$

ought to have been used going west against 116 feet east for a paying traffic of three tons west to two tons east.

As the grade approaching the Kicking Horse Summit from the east scarcely exceeds this and is only one mile in length, by a proper adjustment of the weight of engine to traffic the fifty miles extending to the Columbia river can be very economically worked with an assistant engine, the round trip of 100 miles being a fair day's run for a freight engine. As the next thirty miles down the Columbia river has no grades exceeding 40 feet per mile it can be easily worked with one engine. On the 60 miles crossing the Selkirks the grades are 116 feet in both directions, and as the engine power must be sufficient for the load of 339 tons going west, the loss of engine power coming east would be sufficient to haul 339 tons — 282 tons = 57 tons net weight, and $\frac{57}{339} = 0.168$. That is 17 per cent. of the power of both engines is wasted. To be well within bounds it may be taken as 25 per cent. of the power of one engine. Wellington gives the cost of assistant engine service as 47·100 of the cost per train mile, which would make the capitalized cost of assistant engine service per mile of incline, with interest 6 per cent. and cost per train mile $1, $5,092 for each daily train.

As for passenger traffic the same grades in both directions would be no disadvantage, this estimate will be made for two daily trains, cost per train mile $1.75, interest 6 per cent., with one incline of 30 miles in length.

Cost of one assistant engine for two trains per day on incline of thirty miles in length, $5,092 × 30 × 1.75 × 2 = $534,660, 25 per cent. of which is $133,665, and is the amount that might have been profitably expended in reducing the grade going west from 116 feet to 98 feet.

The writer is not prepared to say whether this could have been done; but as the maximum grade is not used continuously going west the grade might probably have been reduced somewhat.

The writer regrets his inability to give more complete and accurate information in regard to the western portions of the line; but while some of the necessary data have been assumed, it is believed that the excess (if any) has been in underestimating, rather than exceeding the value of any changes suggested.

While it appears that had there been the careful and intelligent study of the subject, which the magnitude, and cost of the work justified, a far better line to operate could have been secured at little if any increase of cost, it is perhaps only justice to the officials who have had most of it in charge, to say, that they came into power and assumed the control just at the time the contract was made with Langdon, Shepard & Co., to construct 500 miles of the road in one year, and that their attention was entirely taken up with matters pertaining to the construction, which undoubtedly appeared at the time to be of the greater importance.

THE LEGAL POSITION OCCUPIED BY A SURVEYOR IN THE STATE OF MICHIGAN.

By HON. L. S. MONTAGUE, of Howell.

After the able paper by Mr. Justice Cooley, read before this Association, which covers a portion of this subject, it will be more difficult for me to add anything that is interesting or instructive.

The statutes of this state have undertaken to fix the legal position of the county surveyor,

Howell's Statutes, Sec. 614 to 625 inclusive,

and have provided that the certificate of the county surveyor, or his deputy, of any survey made by him of any lands in his county shall be presumptive evidence of the facts therein contained, unless he shall be interested therein, and that in such case the survey and certificate shall be made by a county surveyor of an adjoining county; but such certificate, to have that effect as evidence, must contain the particulars which the statute requires to be entered in the county surveyor's record of surveys, namely: The courses and distances of all lines run and the number of acres contained in each piece of land surveyed, to be entered on the diagram of the section in the record book, subdivided according to the survey thereof, the time when, the name of the person by whom, and the person for whom the survey was made, a description of all witness trees marked on the survey, with their respective courses and distances, and the variation of the magnetic from the true meridian. These certificates have very frequently failed to be of value, on account of the absence of some of the requisites.

Smith vs. Rich, 37 Mich. Reports, 553.

The county surveyor is required to record his own surveys and those of other surveyors, made in his county, if the fees are paid and the survey appears to have been made in accordance with the laws of this state. He shall make surveys in his county when required by courts and on the application of any person, and shall establish, re-locate and perpetuate corners and lines, when a majority of the resident owners of any section, or part or parts of any section, shall desire it done and have given the proper notice, and he shall not be liable to prosecution for trespass for entering on any lands in the discharge of his duties.

Some of these prescribed duties and privileges seem unnecessary and some illegal.

The records of surveys by surveyors other than county surveyors,

even if they "appear to have been made in accordance with the laws of this state," were not evidence at common law,

Smith vs. Rich, 37 Mich. Reports, 553,

and as they are not made competent evidence by statute, they are practically useless for that purpose; and it is not so clear when they are in accordance with the laws of this state, unless they are to include the requisites of the county surveyor's record; for the statute nowhere else points out the manner of making surveys, or rather certificates or memoranda thereof, except of town plats,

Howell's Statutes, Sec. 1473,

and while the county surveyor might very properly perpetuate the monuments of corners and lines, he cannot legally establish or re-locate them, and thereby bind the owners of the lands, any more than any other man.

Cronin vs. Gore, 38 Mich. Reports, 386;
Stewart vs. Carleton, 31 Mich. Reports, 273.

The original survey must govern; for under that the lands were purchased and the rights of the owners have become vested. The duties and powers of the county surveyor, as well as other surveyors, are confined to ascertaining where the corners and lines of the original survey were established, and he cannot make a new survey, changing those lines and corners, although it might be mathematically more correct.

Diehl vs. Zanger, 39 Mich. Reports, 605.

The only advantage that the county surveyor seems to possess, over the non-official surveyor, in the actual work of making a survey and in the application and enforcement of the result of the work, is in the immunity from actions of trespass, and in his certificate being presumptive evidence of the correctness of his survey.

These privileges were probably granted to him because of his public character as a public officer, but they are practically of slight value.

While the legislature has deemed it important enough to exempt engineers in surveys of railroads from liability for entering on lands for that purpose, except for actual damages,

Howell's Statutes, Secs. 3323 and 3461,

and while possibly surveyors might be liable for a technical trespass in entering on lands to make surveys without the consent of the owner, probably none of you have had actions brought against you for such trespass, and if you should have that mishap, very likely the courts would hold under the decision in Marsh vs. Colby, 39 Mich. Reports, 627, that as it has been customary to enter upon lands and make surveys, in the absence of any notification to the contrary, one may understand that he is licensed to do so, and is not therefore a trespasser.

The statute makes the county surveyor's certificate *presumptive evidence* of the facts therein contained. Presumptive evidence is that which stands good and sufficient to determine the matter in issue *unless* or *until* rebutted, contradicted, or explained.

Burrill on Circumstantial Evidence, 90.

Therefore the certificate is more a matter of convenience of proof than of actual weight, for it is liable to be rebutted, contradicted, or explained by the parole testimony of other surveyors and of other persons of no professional knowledge or experience.

The field notes of the United States survey are *prima facie* evidence of the location of lines and corners, when the monuments cannot be found, for the monuments made in the field must govern.

Cofield vs. McClelland, 16 Wallace, U. S. Reports, 335.
People vs. Dennison, 17 Wendell Reports, 315.
McIver's, Lessee, vs. Walker, 9 Cranch's Reports, 177 and 178.

Town plats, which are original surveys, for the subsequent determination of the boundaries of the lands therein contained, are also admissible in evidence, whether made by a county or other surveyor,

Howell's Statutes, Sec. 1473,

but the platting stakes govern, and the question on a subsequent survey is not whether the stakes were where they should have been in order to make them correspond with the lot lines in the plat, if the platting were done with absolute accuracy, but is whether they were platted by authority, and the lots were purchased and taken possession of in reliance upon them.

Flynn vs. Glenny, 51 Mich. Reports, 584.

With the above exception, the legal position of all surveyors is the same, unless there may be special duties and privileges under the charters of some of the cities and villages, and save the official character of city and village surveyors, or of surveys made by them under Sections 2488 and 2820 of Howell's Statutes.

Beeman vs. Black, 49 Mich. Reports, 599.

And what I shall say further will apply to surveyors generally. Act No. One Hundred and Forty-nine of the Session Laws of 1883, "To authorize the boards of supervisors of the several counties of this state to provide for ascertaining, preserving and maintaining the original section corners and quarter posts, as surveyed and recorded by the original survey," provides that the surveyor employed shall keep a full and complete record of his work, which record shall be kept in the book provided by the county for surveyors' records, and kept in the office of the county surveyor, and that the record so made and entered shall be received as evidence in all the courts of this state, wherein any question may arise as to the establishment or identification of such corner or corners. Otherwise the field notes, certificates and records of surveys made by surveyors are not competent evidence in courts of the facts they contain, unless performed under highway or drain commissioners, or other public officers or courts, and made competent evidence, under the statutes, or as parts of proceedings under public authority and of a public nature.

People vs. Dennison, 17 Wendell's Reports, 315.

The results of surveys are useful and important in two ways: 1. To determine lines, boundaries and corners in suits in courts involving

them. 2. To determine those questions in cases that are never litigated in courts.

In only a very small proportion of the surveys made do courts and juries follow after the surveyor, over the same ground. In most cases the surveyor is called upon to make a survey by the owners of the lands, who have confidence in his skill and integrity, and who frequently accompany him in his work as assistants or interested spectators. He proceeds with the survey, using all the information at hand—monuments, field notes, witness trees, old fences, etc.—and inquiring into all the facts, and frequently showing his means of knowledge to those interested. It becomes a substantial submission to arbitration by parole, of the lines and boundary, and the surveyor becomes practically an arbitrator, and exercises the judicial function of determining the location of the lines and boundary; for although the submission should be in writing, to affect real estate under the statute of frauds, the parole award, or agreement, would be enforceable when actually executed; and when the lines and boundaries so determined have been recognized and acted upon by the adjoining owners, by conforming their occupation to them, they become finally determined as firmly as if passed upon by courts and juries.

Cronin vs. Gore, 38 Mich. Reports, 384.
Smith vs. Hamilton, 20 Mich. Reports, 438.

And even if the survey is not made with the joint consent of the owners, if it is made, and the lines and boundaries determined by the surveyor, and accepted and acted upon, by the exercise of possessory rights and otherwise, by the owners, for fifteen years, the length of time required by the statute of limitations, or perhaps less, the lines and boundaries become fixed, without court or jury.

Stewart vs. Carleton, 31 Mich. Reports, 273.
Diehl vs. Zanger, 39 Mich. Reports, 603, 605 and 606.
Pratt vs. Lewis, 39 Mich. Reports, 12.
Flynn vs. Glenny, 51 Mich. Reports, 583,
Baker vs. McArthur, 19 Northwestern Reporter, 925.
Crowell vs. Beebe, 10 Vermont Reports, 33.

When lines and boundaries are in litigation in court, and before they have been settled by the said practical arbitration and acts thereunder, or by lapse of time, possession and acts of owners, relying on previous surveys, and when the question of where were the lines and corners located by the original government survey, or by the town plat, is still open in that forum, the legal position occupied by the surveyor is very different, and he becomes only a witness to the facts, that shall establish the location of said lines, boundaries and corners, and an expert witness as to matters of fact requiring special knowledge and with which he is familiar, in cases where better means of information do not exist, a very useful assistant in coming to a correct judgment, but still *only* a witness.

Stewart vs. Carleton, 31 Mich. Reports, 273.

He has no more authority than other men to determine boundaries on his

own motion, and the law itself does not make him the arbiter of private rights.

Cronin vs. Gore, 39 Mich. Reports, 386.

All bounds and starting points are questions of fact to be determined by testimony; and not of the surveyor alone, but by all testimony that is relevant to the issue that can be obtained, including that of unprofessional witnesses.

Hoffman vs. Harrington, 44 Mich. Reports, 185.

As the surveyor will generally have more accurate knowledge of the facts that should determine the lines and corners than any other witness, his testimony will usually be very important, and often controlling; but its weight will depend upon his knowledge of the facts and his thorough and clear statement of them, and not upon his opinion of where the line is located.

Stewart vs. Carleton, 31 Mich. Reports, 274.

Still, he is allowed as a witness to give opinions of matters with which he is familiar by reason of his employment, where better means of information do not exist; as whether in his opinion certain marks on trees and piles of stone were intended as monuments of boundaries.

1 Greenleaf on Evidence, Sec. 440.

But whether an allowance for the variation of the compass should be made, to determine the location of the lines and boundaries, and if so, how much allowance should be made, are questions of fact under all the proof for the jury to decide.

Harlan vs. Brown, 2 Gill, Maryland Reports, 475.
Same case, 41 American Decisions, 438.

While, as has been stated, private surveys, or plans or memoranda of them, made without public authority, are not admissible as evidence of the facts therein, for the reason, as has been said, that it might benefit men to include in such surveys more than belonged to them;

Jones vs. Huggins, 1 Devereaux's Law, North Carolina Reports, 223.
Same case, 17, American Decisions, 569.

Yet after the draft of a survey had been proven by the surveyor who made the survey and the draft, it was held to be admissible in evidence for the purpose of explaining what he testified he had done in making the survey.

Hoey vs. Furman, 1 Pennsylvania State Reports, 295.
Same case, 44 American Decisions, 129.

Field notes, memoranda, drafts and plans of surveys made by a surveyor himself, or by another person at his dictation, may be referred to by him, while under examination as a witness, for the purpose of refreshing his memory, where his recollection is not sufficient to enable him to answer the questions without it.

Abbott's Trial Evidence, 320.
Raynor vs. Norton, 31 Mich. Reports, 213.

But if they are used to refresh the memory of the witness, the opposite party, from the one in whose behalf he is sworn, has the right to have them produced and to know what the memorandum is, and whether it had any legitimate tendency to bring the fact in controversy to mind.

Duncan vs. Seeley, 34 Mich. Reports, 370.

The boundaries will usually be mainly decided by the court and jury on the testimony of the surveyor, as he will be the only witness who has all the available facts bearing upon them in his possession. Whether as an arbitrator, the maker of a survey which becomes fixed by time and acceptance, or as a witness to facts in court, including the giving of an opinion as an expert, the legal position of the surveyor is such that he, more than all other agencies combined, fixes and determines boundaries of lands and the limits of their ownership.

LEGAL REQUIREMENTS FOR VILLAGE PLATS.

By. G. E. STEELE, Traverse City.

It is the purpose of this paper to prepare the way for such office work as the surveyor has to perform and in which, especially in the making of village plats, he must judge of the law, as well as the conveyancer who draws a deed or a mortgage. All the more is this important when the law is conflicting and has been made of fragmentary amendments. Until Act No. 108 of 1873 took effect, village plats might be of any size or shape; they might be drawn on any scale; the recording was generally done by filing a copy with the Register of Deeds, who was not supposed to know whether it was a true copy or not, and for fear this might be questioned, he would securely tie it in a snug roll, and deposit it in the back room, with other rubbish. We once saw a Register faithfully transcribing a plat on to his deed record and trying to draw across the fold of the book on both pages. This being done, the finish was put on by a few spatters of ink.

The law of 1873 was quite an improvement, though in its workings not all it should be. It amended Section 1,344 of the Comp. L. 1871, and left Sec. 1,345 unchanged. The consequence is that the law as it stands is not homogeneous, and is liable to misinterpretation. Taking the Comp. L. of 1882, Sec. 1,473 (which is the same as the amendment of 1873 left it) we note briefly that:

1. The proprietor must cause three plats to be made by some competent person, each 18x24 inches in size on muslin backed paper.

2. There must be written upon the plats a detailed description of the land embraced in the plat, by section, town and range, the name of the village, of the proprietor, and person making the plat. The plat must also show the cardinal points and be drawn to a scale, not showing more than 200 feet to one inch.

3. The proprietor and person making the same shall sign the plats (except the third one may be a copy) and they "shall be witnessed and acknowledged as deeds conveying land are required to be witnessed and acknowledged."

4. The section and subdivision lines should also be drawn and plainly indicated.

The original plat retained by the proprietor is to be recorded in the office of the Register of Deeds for the county by filing with the Register an exact duplicate with actual signatures of the several parties. A true transcript of the record is then to be delivered to the Auditor General,

and filed in his office; these plats all having been compared by the Register, and person making them, and so certified.

We next notice the section following (1,474) which stands as it was in 1859. It provides for the regular description of the land or for defining it by metes and bounds; of the public grounds, streets and alleys by their dimensions, names or numbers, and the numbers of the lots and blocks with the size. It further says "and the maps so made and acknowledged by the civil engineer and surveyor making the same, and by the proprietors thereof, before a Justice of the Peace, or a Notary Public of the proper county where the town, city, village or additions lie, or before any judge of any court of record, and certified under the hand and seal of the Judge, Justice or Notary Public taking such acknowledgment, and recorded, shall be deemed a sufficient conveyance to vest the fee of such parcels of land as are therein expressed, named or intended for public uses in the county in which city, village or additions lie, in trust to and for the uses and purposes therein named, expressed or intended, and for no other use or purpose whatever."

You will readily observe that these two sections, the one for the most part thirty-four years older than the other, do not agree. We claim that the first section requires the person making the plat to sign it, and that the proprietor must sign and execute the plat, as if it were a deed, that is, in the presence of two witnesses, and before an officer who can take acknowledgments; and nothing is said of the official seal. By that section the surveyor is not required to acknowledge the plat any more than the surveyor of a farm is to acknowledge the execution of the deed of that farm.

By the next section, (1,474), it might be thought that the surveyor and proprietor were both required to acknowledge the plat. But a careful reading will show that if they do both so acknowledge before a Judge, Justice, etc., having a seal, *it will be a sufficient conveyance to vest the fee of those parcels as are intended for public uses in the county in trust. Per contra* the same would be true if the surveyor had never signed nor acknowledged the plat. A warranty deed from the owner could do no more than his properly executed plat. In 41 Mich. 724, "No plat can be made except by the proprietor. * * When properly executed and acknowledged it operates to create interests and burdens which none but the owner can establish, and is for those purposes a conveyance" and the 38 Mich. 761, in discussing the grant and the importance of the acknowledgment the court says "the acknowledgment is the essential act of dedication, and without it a plat has no force in itself for any purpose. * * Whoever makes and acknowledges it is to be regarded as making and acknowledging a dedication or grant to the public, whose representatives are the only parties. * * Such persons executing and acknowledging the plat convey whatever right they have in the lands dedicated."

As to the official seal upon plats, Section 1,473 does not require it, for the reason that it is not necessary to a deed. But Section 1,474 is different. In 36 Mich. 122, April, 1877, the court says, "at the date of this plat (October, 1872) the law required the acknowledgment of plats to be under the

seal of the acknowledging officer. * * A recorded copy of a plat bearing the certificate of a Notary, which is not under seal, is insufficient to establish the plat and to prove the existence of a highway by dedication by the proprietor."

This was high authority in 1877 and ought to be now, for the same law is in force word for word. We fear there are many plats that have not on the *official signet! As to sales* under a defectively executed plat, we would refer to 42 Mich. 609, the court says, "the errors, inaccuracies or unskillfulness of the draughtsman can not be permitted to change or effect the rights of parties," also 11 Mich. 232, Christiancy J. says, "the ground upon which these questions were objected to and excluded by the court was that a plat must first be proved, properly acknowledged by the proprietors to entitle it to be recorded. * * Both objections seem to have been based upon the idea that every town or village plat not properly recorded by the proprietors, according to the statute in reference to town plats (or at least not so executed and acknowledged as to entitle it to be recorded) is so entirely void and illegal that no conveyance describing the lands by reference to such plat only can be valid. * * We think these grounds wholly untenable. * * None of our statutes in reference to town plats go so far as to render deeds of conveyance between individuals void because made by reference to an unacknowledged or unrecorded plat. * * But any such plat or any other map or plat, whether to be found in a public office or in the possession of any person, may still be used for identifying the land intended to be conveyed, though no description be given except by reference to such plat by which the property conveyed could be ascertained."

Also in 46 Mich. 83, April, 1881, the court says, "a conveyance is not invalidated by the fact that the plat of land referred to in the description is not recorded or that so much of the description as refers to the plat is incorrect; the land may be identified by parole evidence." These citations sufficiently establish the sales so made, but do not legalize defective plats either for evidence or record. To still further show the misinterpretations of these two sections of the law we refer to an instance which came to our knowledge. The Register of Deeds is required to examine the plats and if he find that "in any respect they fail to conform to the requirements of this act (1873) he shall point out the deficiency and return them for correction." For any wilful violation the Register is to pay ten dollars and damages. Thus he is made a Supreme Court at each county seat, setting himself up to decide what are and what are not *legal plats*; what would and what would not render him liable for the ten dollars and damages. Of course if there is a shadow of doubt he puts the doubt on his side and refuses, even on a mere pretext, to receive the plats; and thus throws the proprietor out of sales, and blocks his way. Thus in the case to which we refer he says:

1. "The Surveyor has not acknowledged the plats." This we have already disposed of.

2. "No proper detailed description of the land platted. * * The description must fully describe the land platted without reference to streets of other plats."

In this case the plat was very irregular and a description by metes and bounds would take much space, besides not being easy to follow. The plat was only a small addition to a recorded plat, and reference was made to these streets. We claim the surveyor did right, because a recorded instrument can be used and made a part of another instrument to go upon the same records. A deed need not give any description except to incorporate another by reference.

3. "The person making the plat should come to this office with the plat and compare it with the Register, as each must certify that both have compared it."

The law says nothing of the two being together when the comparison is made, and it is hardly to be supposed that one must certify to a mental act done by another. Each should do the work thoroughly and independently, whether they do so at one time or not.

4. "The cardinal points are not marked." This, let us say, was not intended as a joke on the draughtsman, for he had spent much time on a *fleur-de-lis* to show the north point. But the Register having the north could not find the others.

5. "The plat should be marked in feet, not in chains and links." We can not find such a requirement.

Suggestions.—Now if it is thus possible, by either the ignorance, fear, or perverseness of any officer to so interfere with the rights of any proprietor or the reputation of a surveyor, ought there not to be some remedy? An occasional Register surcharged with a sense of his duty should not be able to fill the positions of judge, barrister and jury all at the same time. If the plat should not in all respects come up to his ideal, the responsibility might be left where it belongs.

There can be no doubt that greater uniformity would be had by sending the three plats first to the Auditor General, where certain defects, if existing, should be pointed out, and when made correct, such officer should approve them, file one and send two to the Register of Deeds, whose only duty would be to enter them for record of that date, notify the Auditor General of the reception, then file one, and deliver the other to the proprietor. The Auditor General would soon systematize the recording of plats, better than we can ever hope to secure by so many different county officers. The recent circular of November 29, 1884, from the Auditor General, in relation to this subject shows the importance of a better understanding by all persons interested, and indicates that he is powerless to make any improvements, unless the wording of the law is somewhat changed.

LIST OF MEMBERS WITH RESIDENCE AND BUSINESS.

ALLINGTON, D. K. ..... East Saginaw, Saginaw Co.
Mechanical Engineer and Architect.

ALLEN, JEROME. ..... Milan, Monroe "
Surveyor.

APPLETON, WILLIAM. ..... Lansing, Ingham "
City Engineer, Landscape Gardener.

APPLEYARD, WILLIAM P. ..... Lansing, Ingham "
Architect and Engineer.

ARNOLD, ANSON R. ..... Mt. Pleasant, Isabella "
Surveyor and Drainage Engineer.

ARNOLD, WALTER D ..... Mt. Pleasant, Isabella "
Surveyor and Drainage Engineer.

BAILEY, M. H ..... Dimondale, Eaton "
Surveyor.

BAMBER, HERBERT ..... Highland, Oakland "
U. S. Asst. Engineer, Monongahela River.

BANNISTER, A. M. ..... Jackson, Jackson "
Chief Asst. Eng'r. Central American Pacific R. R., Guatemala.

BARNARD, HORACE ..... Frederick, Dakota.
Railroad and Civil Engineer.

BARTHOLEMEW, H. D. ..... Lansing, Ingham Co.
Civil Engineer.

BATES, ARTHUR W. ..... Gaylord, Otsego "
Deputy Surveyor, Otsego County.

BECKMAN, L. ..... Toledo, Ohio.
Manufacturer of Surveying Instruments.

BEAN, H. F. ..... Jackson, Jackson Co.
Railroad Engineer.

BEDEN, SETH N. ..... Pine Run, Genesee "
County Surveyor, Civil and Drainage Engineer.

BEGLE, CHAS. A. ..... Detroit, Wayne "
Real Estate; Engineer of Preston & Co.'s Land Department.

BELLOWS, C. F. R. ..... Ypsilanti, Washtenaw "
Civil Engineer; Professor Mathematics, State Normal School.

BLAIR, JAMES ..... Adrian, Lenawee "
County Surveyor.

BONNELL, B. C. ..... Lake City, Missaukee "
Surveyor; Member Legislature 1883-84.

BRADT, JOHN C.....Marcellus, Cass Co.
Surveyor and Farmer.

BRECKENBRIDGE, C. S.....East Saginaw, Saginaw "
Sewer Engineer.

BROWN, GEO. M.....East Saginaw, Saginaw "
General Roadmaster, F. & P. M. Ry.

BROWN, PARKER M.....Smith's Creek, St. Clair "
Surveyor and Civil Engineer.

BROWN, THOS. J.....Mason, Ingham "
Former Deputy U. S. Land Surveyor. Age 80 years.

BULLOCK, M. W.....Howell, Livingston "
U. S. Deputy Surveyor; Abstract Office.

CAMPBELL, WM. A.....East Saginaw, Saginaw "
Mechanical Engineer.

CARLTON, GEO. H.....Sault Ste. Marie, Chippewa "
Civil Engineer; Customs Receiver.

CARPENTER, ROLLA C.....Lansing, Ingham "
Civil Engineer; Prof. Mathematics and Engineering, State Agricul. College.

CARPENTER, L. G.....Lansing, Ingham "
Asst. in Mathematics, State Agricultural College.

CARY, HARRISON.....Saginaw City, Saginaw "
Surveyor and Civil Engineer.

CAUKIN, HENRY M.....Greenville, Montcalm "
Engineer Logging Railroads; Surveyor.

CAVIS, C. H. V.....Marquette, Marquette "
Chief Engineer, M. H. & O. R. R.

CHAPPELL, A. J.....McBride, Montcalm "
Surveyor and Engineer.

CHANDLER, GEO. W.....East Saginaw, Saginaw "
Civil Engineer and Surveyor; Late Engineer Mexican Central Railroad.

CHILDS, ADDISON.....Lansing, Ingham "
Asst. Engineer State Capitol.

CLARK, JOHN M.....Howell, Livingston "
Mechanical Engineer and Manufacturer.

COATS, W. R.....Kalamazoo, Kalamazoo "
Hydraulic and Water Works Engineer.

COBB, LEE S.....Hastings, Barry "
Surveyor; Mechanic.

COLLAR, H. A.....Grand Rapids, Kent "
City Engineer of Grand Rapids.

COOK, M. S.....Manistee, Manistee "
Civil Engineer; County Surveyor.

COOLEY, PROF. M. E.....Ann Arbor, Washtenaw "
Professor Mechanical Engineering, University of Michigan.

CROSS, HON. J. S.....Bangor, Van Buren "
Surveyor and Member of House of Representatives.

CUMMINGS, GEO. P.....Marquette, Marquette Co.
Civil Engineer; Real Estate.

DAVIS, FRANK P.....Washington, D. C.
Civil Engineer.

DAVIS, JOS. B.....Ann Arbor, Washtenaw Co.
Asst. Prof. Civil Engineering, University of Michigan.

DEAN, SETH.....Glenwood, Iowa
Civil Engineer; County Surveyor, Mills Co.

DENNIS, E.....Jackson, Jackson Co.
Mechanical Engineer and Manufacturer.

DIXON, J. R.....Charlevoix, Charlevoix "
Surveyor and Farmer.

DOANE, GEO. W.....Pine Run, Genesee "
Surveyor.

DONOVAN, WM.....Lansing, Ingham "
Engineer, Land Department, J. L. & S. R. R.

DOWLING, PHILIP H.....Rome, Lenawee "
Surveyor and Farmer.

DRAKE, A. P.....Mason, Ingham "
Surveyor.

DREW, ALBERT L.....Three Oaks, Berrien "
Surveyor and Civil Engineer.

DUNBAR, E. L.....Bay City, Bay "
Civil Engineer; Superintendent Bay City Water Works.

EATON, ALBERT.....Otsego, Allegan "
County Surveyor; Civil Engineer.

ELLIOT, WM. P.....Chicago, Ill.
Mechanical Engineer and Manufacturer.

FESSENDEN, C.....Yankton, Dakota Ter.
Surveyor General of Dakota.

FOSDICK, ALBERT A.....Williams, Kalamazoo Co.
County Surveyor.

FOSTER, R. J.....Coopersville, Ottawa "
Surveyor.

FOWLER, GEO. L.....East Saginaw, Saginaw "
Mechanical Engineer.

FREEMAN, GEORGE.....Edenville, Midland "
County Surveyor, Gladwin County.

FROST, GEO. H.....New York, N. Y.
Civil Engineer; Editor "Engineering News."

FULLER, A. G.....Kalamazoo, Kalamazoo Co.
Assistant City Engineer.

GARDNER, ALBRO.....Seante, Wyoming Ter.
Engineer Oregon Railroad.

GOODELL, E. J.....Ecorse, Wayne Co.
Surveyor.

GOODALE, O. C.....Chesaming, Saginaw Co.
Surveyor.

GRAHAM, JAS. A.....Calkinsville, Isabella "
County Surveyor.

GRANT, WM.....East Saginaw, Saginaw "
Civil Engineer; Street Commissioner.

GRANT, E. W.....La Junta, Colorado.
Resident Engineer, A. T. & S. F. R. R.

GRANVILLE, JOHN J.....East Saginaw, Saginaw "
Civil Engineer; City Surveyor,

GREENE, CHAS. E.....Ann Arbor, Washtenaw "
Civil and Consulting Engineer; Prof. Civil Engineering, U. of M.

GREENE, JAMES P.....Oxford, Oakland "
Chief Engineer P. A. & O. Railroad.

GREINER, ROBERT C.....Grand Rapids, Kent "
City Draughtsman.

GUILD, E. F.....East Saginaw, Saginaw "
Surveyor and Civil Engineer; Dealer in Real Estate.

GUILEY, D. E.....East Tawas, Iosco "
Surveyor and Civil Engineer.

GURLEY, L. E.....Troy, N. Y.
Manufacturer of Surveying Instruments.

HASTINGS, FRANK W.....St. Louis, Gratiot Co.
Surveyor and Civil Engineer.

HASTINGS, SYDNEY S.....St. Louis, Gratiot "
Surveyor and Engineer; Real Estate.

HEALD, PERLEY C.....Midland, Midland "
County Surveyor and Real Estate.

HEMINGWAY, LUTHER.....Benton Harbor, Berrien "
County Surveyor.

HEYDEN, OLIVER S.....Indian River, Cheboygan "
County Surveyor and Civil Engineer.

HODGMAN, FRANCIS.....Climax, Kalamazoo "
County Surveyor; Civil Engineer.

HODGMAN, SAMUEL C.....Haines City, Florida.
Surveyor and Civil Engineer.

HOLDEN, D. F.....Oviatt, Leelenaw Co.
Surveyor.

HOLLISTER, CHAS E.....Laingsburg, Clinton "
Surveyor and Drainage Engineer.

HOLMES, CHARLES.....East Saginaw, Saginaw "
Surveyor and Civil Engineer.

HOLMES, J. W.....Batavia, N. Y.
City Engineer; Manufacturer of Solar Apparatus.

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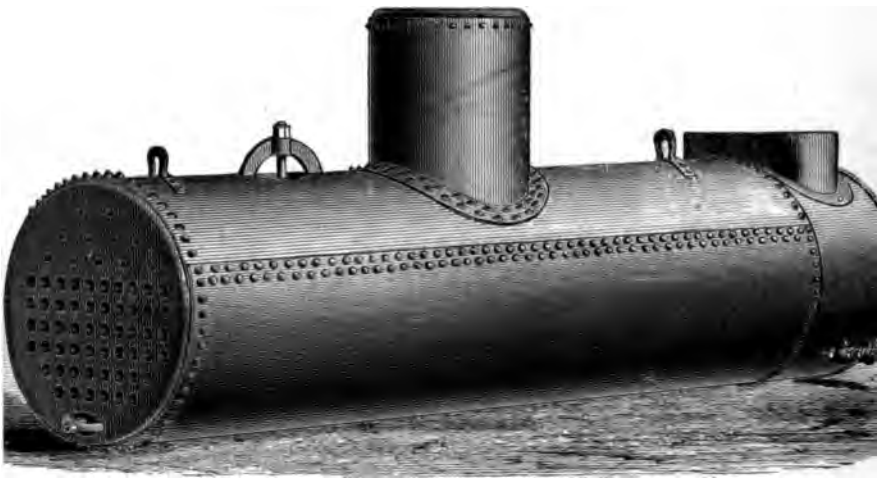

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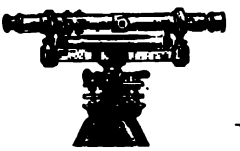

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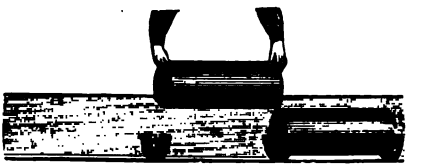

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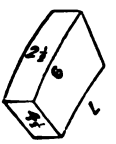

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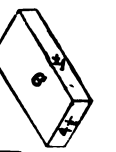

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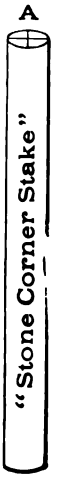

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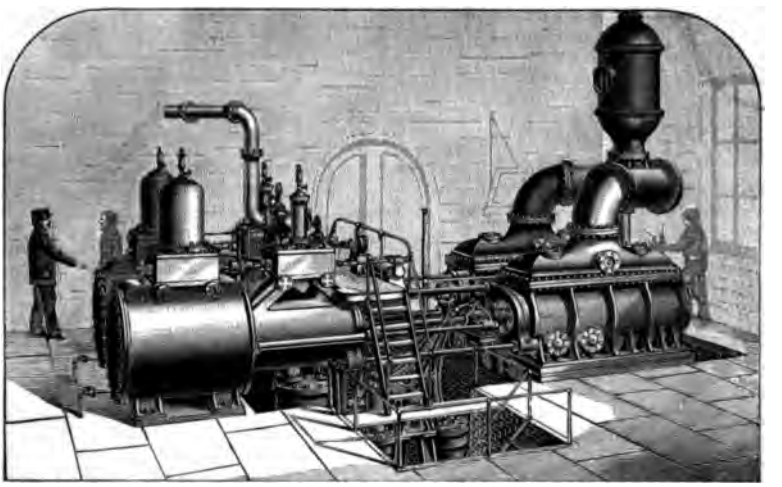

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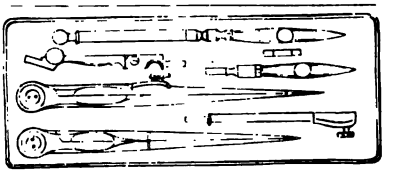

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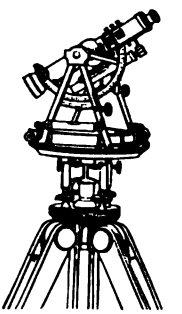

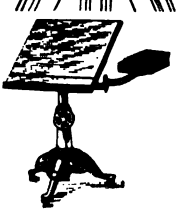

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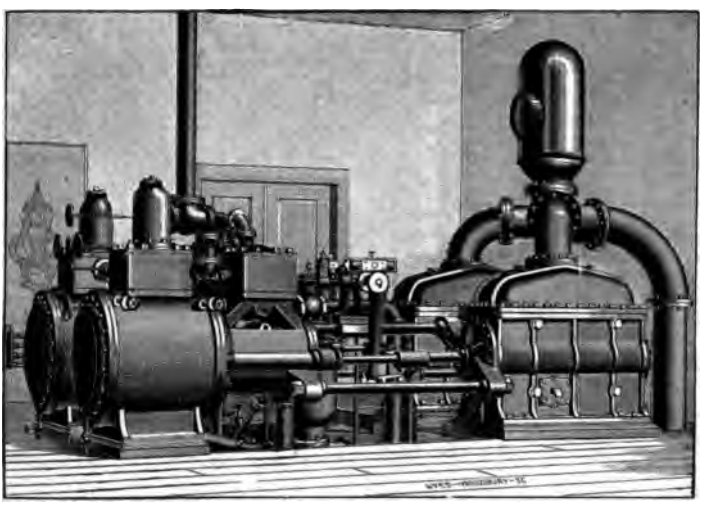

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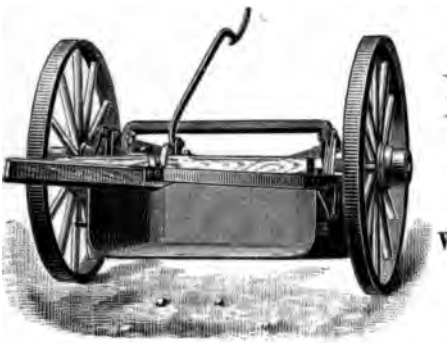

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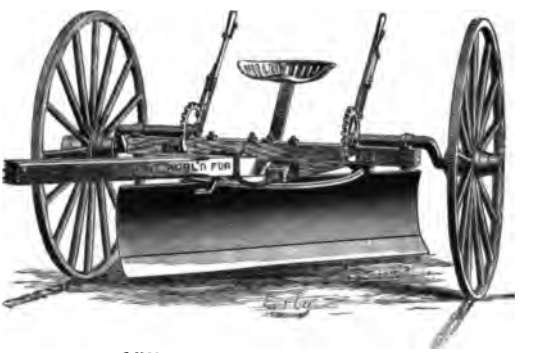

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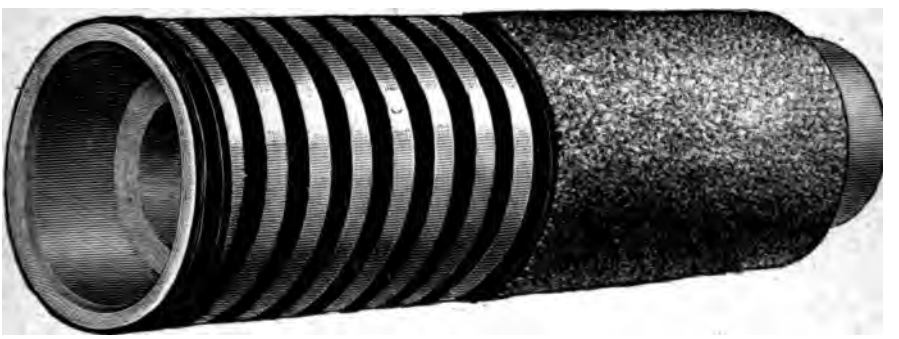

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Michigan Engineering Society.

ORGANIZED AS MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS AT LANSING, MARCH 25, 1880.

OFFICERS, 1886.

PRESIDENT, PROF. JOSEPH B. DAVIS, of Ann Arbor.
VICE PRESIDENT, GEO. E. STEELE, of Traverse City.
SECRETARY AND TREASURER, H. D. BARTHOLOMEW, of Lansing.*

EXECUTIVE COMMITTEE.

DORR SKEELS, of Grand Rapids. PROF M. E. COOLEY, of Ann Arbor. E. F. GUILD, of East Saginaw.

STANDING COMMITTEES.

Manual—F. HODGMAN, of Climax. GEO. E. STEELE, of Traverse City. C. F. R. BELLOWS, Ypsilanti.

Publication—H. D. BARTHOLOMEW, of Lansing. LOUIS MCLOUTH, of Lansing.

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Highways and Highway Bridges—GEO. S. PIERSON, of Kalamazoo, Chairman. J. S. CROSS, of Bangor, Van Buren County. WM. P. APPLEYARD, of Lansing.

State Boundaries—JAS. C. LEONARD, of Union City, Branch County. BURTON KENT, of Adrian. (No Chairman).

* Prof. R. C. Carpenter of Lansing was elected Secretary and Treasurer at Ann Arbor, but resigned and his place was filled by action of the Executive Committee June 1st, 1886.

ACTING SECRETARY'S APOLOGY.

At Ann Arbor the chairman of the committee on nominations was informed that I would be glad to do what I could, but I had just made an engagement that would occupy my time from 12 to 16 hours a day for the next five or six months.

The middle of June I received a letter from a delinquent member with his dues and a printed circular, stating I had been appointed successor to Prof. Carpenter by the Executive Committee. It was the first of August before I had time to look over the papers and books delivered to me. The pressure from my private affairs has been increasing instead of diminishing ever since.

The papers by A. C. Sekells, of Grand Rapids and Frank P. Davis of Washington were sent at the request of the writers and by the advice of the secretary to the Sanitary News of Chicago, after they had pledged themselves to return the papers or a printed copy. They printed a short abstract of the papers but have failed, after repeated requests, to return the original manuscripts. Hence their non appearance in these proceedings.

H. BARTHOLOMEW.

Michigan Engineering Society.

SEVENTH ANNUAL CONVENTION HELD AT THE STATE UNIVERSITY IN THE CITY OF ANN ARBOR, JAN 26, 27, 28, 1886.

The following general programme was adopted by the Executive Committee.

ANNOUNCEMENT.

TUESDAY, JANUARY 26, 2 P. M.

Reports of President and various permanent committees, appointment of new committees, and organization of sections.

7:30 P. M.—Address of the President, "Technical Education."

WEDNESDAY, 9 A. M.

Meeting of standing committees to pass on papers to be read.

9:30 A. M.—Meeting of the society in three separate sections as follows: Section A, Surveying; Section B, Civil Engineering; Section C, Mechanical Engineering.

2 P. M.—Excursion to various points of interest at the University.

7:30 P. M.—Address before the whole society.

THURSDAY, 9. A. M.

Continuation of excursion.

2 P. M.—Meeting of societies in three separate sections.

7 P. M.—Meeting of standing committees.

7:30 P. M.—Address before the whole society general session.

JANUARY 27, 1886.

9:30 A. M.

GENERAL SESSION—UNIVERSITY CHAPEL.

10 A. M.—MEELING IN SECTIONS.

SECTION A.—SURVEYING.

GEORGE E. STEELE, Chairman.

Underground Surveying—H. B. Sturtevant, Marquette, Mich.
Village Plats—H. D. Bartholomew, Lansing.
Questions of Practice.

SECTION B.—CIVIL ENGINEERING.

FRANK HODGMAN, Chairman.

Iron Substructure as a substitute for masonry—F. J. Sager, Ohio.

SECTION C.

JESSE SMITH, Chairman.

The Westinghouse Air Brake—Prof. M. E. Cooley.

2 P. M.

Excursion to University in charge of Prof. C. E. Greene.

7:30 P. M. GENERAL SESSION.

Water Supply—A. C. Sekell, City Engineer, Grand Rapids.
Remarks on the Ann Arbor Water Works—Prof. C. E. Greene.

JANUARY 28, 1886.

9:30 A. M. MEET AT ROOM 2, UNIVERSITY.

Proceed to examine City Water Works.

2 P. M.—ROOM 1.

SECTION A.—SURVEYING.

GEO. E. STEELE, Chairman.

Paper by F. W. Gardam, New York.
Paper by T. L. Johnson, Philadelphia, also remarks by L. Beckman, Toledo and Wm. F. Gurley, Troy, N. Y.
The Land we Survey—Geo. E. Steele.

SECTION B.—CIVIL ENGINEERING.

FRANK HODGMAN, Chairman.

Ditching by Machinery—E. D. Shreve.
Main Sewer, City of Washington—Frank P. Davis, Washington, D. C.

SECTION C.—MECHANICAL ENGINEERING.

JESSE SMITH, Chairman.

Notes on Mechanical Engineering—Frank Kirby, Detroit Mich.
Pile Drivers for Railroad work—W. L. Clements, Bay City.
Motive Power in Elecric Lighting—Jesse Smith.

7:00 P. M.

GENERAL SESSION—CHAPEL.

Reports of Committees. Election of Officers.

ABSTRACT OF PROCEEDINGS.

The evening of January 26, 1886 the reports of the Secretary and Treasurer were made and committees appointed for the following special purposes:

Committee to settle with Treasurer, A. L. Reed, T. W. Pettee, B. F. Welles.

Committee on the death of Mr. James Sanderson, H. C. Thompson, Prof. C. F. R. Bellows, Albert Eaton.

MICHIGAN ENGINEERING SOCIETY, JAN. 26, 1886.

REPORT OF THE SECRETARY.

The Secretary wishes to call attention to the increasing expenses of the society as compared with the income for the last two years:

At Saginaw meeting 1884, balance on hand	$95 19
At Lansing meeeting 1885, balance on hand	52 39
At Ann Arbor meeting, balance on hand	7 24

It is easy to show how this extra expenditure has been made for it is found in the increased expense attending the publication of the proceedings and the increasing cost of distributing the same.

The society never was in a more prosperous condition so far as actual receipts are concerned, and if the expenses can be reduced correspondingly it may be able to accumulate again quite a balance.

The question of the publication of our proceedings should be fully considered. This is the principal expenditure and one that is of vital interest. The cost can be lessened by ordering the committee on publication to require an abstract of each paper of those who read papers, to be of such length as such committee shall decide. If possible the cost of publication should be kept at about $200 per year.

You will notice that our principal revenue for publication comes from our advertisers. The advertisements in proceedings of 1885

amounted to	$208 00
or more than two-thirds of the cost of publication.	
Sale of proceedings amounted to	$ 23 29
	$231 29
Leaving a balance to be paid by society	$ 77 68
	$307 97
Postage and expense on proceedings, add	42 90
Cost of proceedings to society	$119 88

I think it is no detriment to the society that the publication of the proceedings are very much delayed--although it was a great source of annoyance to the publication committee and to the society.

We have exchanged proceedings with the societies of Missouri, Ohio, Indiana and Nebraska, of which Nebraska proceedings have at this date not been distributed. This has given our members publications of fully double the value of the amount paid in dues.

We can, if we desire, unite with the Engineering Societies for the publication of our proceedings. This association publishes a monthly journal for which a subscription of $3 per. annum is asked of all who take it. Any society can join this association by paying yearly dues of 50 cents for each member. The other expenses or profits are divided pro rata. This would cost the society $70.50 if we paid only for the members in good standing. Besides that the members would be to an additional expense of $3 each in order to obtain the proceedings. They would receive much valuable matter-- and it might be best policy to join that association. It would at least remove from your officers the responsibility of the publication.

Another method which may be the best way to reach our increased expenses is by increasing our dues. I think this question should be discussed pro and con by the society and decided at this meeting.

1st. Shall we continue our present publication of proceedings—

A—Either by reducing the expense.

B—By increasing the annual dues.

2nd. Shall we join the Association of Engineering Societies formed for that purpose.

I call attention to our *Manual*. We pledged the sale of 300 copies, if the price did not exceed $2, as a society and may be said to have guaranteed that by having on deposite $100. We must work for it. It is without doubt the best publication on the subject ever prepared.

I call your attention to the death of James Sanderson, one of our able members from Detroit and ask that fitting action be taken.

The increased duties of your secretary involves the necessity of some division of labor otherwise the work is likely to be poorly done.

Respectfully submitted,

R. C. CARPENTER.
Secretary.

REPORT OF TREASURER.

RECEIPTS.

Cash on hand as per report of 1885	$ 52 39	
Received from fees of new members	66 00	
Received from dues of members	123 00	
Received from sale of proceedings	24 24	
Received from advertisements	166 00	
Received from relief fund	4 50	$436 13

PAYMENTS.

Printing proceedings	$307 97	
Expenses annual meeting	24 61	
Postage on proceedings	30 90	
Postage on circulars	11 85	
Labor mailing	3 30	
Advertising	2 07	
Express on proceedings	12 00	
R. R. Certificates	2 00	
Expense extra cover	12 30	
Badges	5 64	
Sundry purchases	16 25	$428 89
Balance on hand		$ 7 24

BILLS PAYABLE.

Expenses of Prof. J. B. Davis to Cleveland	$18 20
Printing bill	3 00
Binding bill	3 00
	$24 20

BILLS RECEIVABLE.

From advertisers	$ 42 00
From back dues	69 00
From note of H. Strudwick	25 00
From advanced on manual	93 20
	$229 20

All of which is respectfully submitted,

R. C. CARPENTER,
Treasurer.

To the Michigan Engineering Society:

GENTLEMEN:—Your committee to whom was referred the report of the Treasurer, would respectfully report that they have carefully examined the same and find it to be correct.

A. L. REED,
T. W. PETTEE,
B. F. WELLES,
Auditing Committee.

Ann Arbor, January 27, 1886.

PUBLICATION OF PROCEEDINGS.

The suggestions of the secretary regarding the future publication of the proceedings were discussed at some length by F. Hodgman, G. E. Steele, C. E. Greene, A. L. Reed and others. It seemed to be the unanimous opinion of the members that the society had better continue its present plan of publication. "If it joined the Association of Engineering Societies it would lose to a great extent its identity. The benefits of all publications of the society are shared equally by all the members and the dues should be raised sufficiently to defray such expenses." It was made the special order for January 27, at which time it was unanimously voted to increase the annual dues to two dollars per year.

The Secretary read the report of the Executive Committee in which the recommendation of the adoption of the letter ballot for the admision of new members was involved. This question was discussed quite at length and resulted in the adoption of an amendment to the Constitution and the By-Laws, requiring the use of the letter ballot.

The members were quite unanimous in desiring to raise the standard of admission into the society and the letter ballot seemed to provide the best results. The members generally seemed desirous of making the requirements of admission such as to give all members of the society a reputation for engineering ability.

Professor J. B. Davis explained to the society the object of the meeting called at Cleveland, which is briefly this: To bring such influence to bear upon Congress as shall induce it to place the civil public works in charge of a bureau of civil engineers. This does not contemplate the retirement of the military engineers of ability who may be now employed but its end is, simply to secure the best men for the place—ability, not military standing, should determine the rank of the engineer on civil works. This was made a special order for the evening of January 27.

After a full discussion a committee was appointed as National committee on civil public works as follows: Prof. J. B. Davis, R. C. Carpenter, Wm B. Sears.

The action of the Cleveland convention was also ratified.

The President stated that this work might involve a considerable expense and desired the society to set aside a specified sum or a specified tax per member for this purpose. Considerable discussion was entertained. It seemed to be generally held by the members present, that such action on the part of those present would not be sustained by the society as a whole. The committee were therefore authorized to receive voluntary subscriptions for the carrying out of such work and the Secretary was directed to enclose a slip to each member asking a donation of one dollar for that purpose.

The committee on nomination was appointed by the President consisting of J. J. Watkins, Frank Hodgman, Burton Kent.

The following gentlemen as delegates from neighboring states were present:

Otto J. Klotz, Preston, Ontario, Canada, President of the Association of Dominion Land Surveyors and Astronomer to the Dominion Government.

Lewis S. Alter, Rensselaer Indiana, Corresponding Secretary Indiana Association.

Ezra D. Shreve.

F. J. Sager, formerly President Ohio Association.

General P. Pease, Columbus, Ohio, Manager C. & M. R. R.

These gentlemen were very cordially received and by special vote were accorded all the privileges of members.

EXHIBITION OF INSTRUMENTS.

The following firms manufacturing instruments made an excellent exhibition and were represented as follows:

L. Beckman, of Toledo, by L. Beckman.

W. & L. E. Gurley, Troy, N. Y. by Wm. F. Gurley.

James W. Queen & Co., Philadelphia, by T. L. Johnson.

Wm. Gardam & Sons, of New York, by Frederick Gardam.

These gentlemen were cordially received and allowed a place on the programme.

Their instruments were examined with the utmost interest, and doubtless a strong impression of the qualites of each is retained on the minds of all who saw them.

The committee appointed for that special purpose make a detailed report.

The Morgan Freight Car Coupler was also exhibited by the inventor. It is an automatic coupler with many excellent points.

SECTIONS.

The society organized the Sections by electing officers as follows:

Section A, Surveying, Chairman, Geo. E. Steele.

Section B, Civil Engineering, Chairman, F. Hodgman.

Section C, Mechanical Engineering, Chairman, Jesse M. Smith.

A vote was passed deciding on the organization of Sections, only for the Ann Arbor meeting.

The papers read were usually of general interest but the division into Sections made it impossible to hear them all. For that reason Section A and Section B held all sessions together.

APPLICANTS.

Applicants for membership made during the meeting and approved by the executive committee were granted by special vote the privileges of members during the session.

Applications from the following persons having been in the hands of the executive committee three months and duly approved were accepted:

John L. Jackson, Saginaw.

Thomas Appleton, East Saginaw.

F. G. Rademacher, East Saginaw. (Elected as members).

All other applications, of which there are many, will be voted on by the whole membership by letter ballot.

THE INVENTION OF THE SOLAR COMPASS.

Mr. Hiram A. Burt, of Marquette, Mich., appeared before the society on the evening of January 28th, to secure the endorsement of the society for the bill now pending in Congress to appropriate $50,000 to the heirs of Wm. A. Burt, the inventor of the Solar Compass.

Mr. H. A. Burt is a grandson of the inventor and has also been honored as a Regent of the State University. He set forth the importance of the invention, without which it would have been impossible to survey the mineral lands of the Upper Peninsula of Michigan and large tracts in other parts of the country. This invention was not patented, principally through the pledge of the U. S. land office that if the invention was allowed to become public property ample compensation would be allowed Mr. Burt by the government. To secure this, bills had to pass both Houses of Congress, although little opposition was met, so far, it had only been possible to get it passed in one of the two houses at a single session. The prospects are better now.

It was decided not to endorse this bill as a society but nearly every individual signed the petition of Mr. Burt.

Prof. J. B. Davis said the invention was a remarkable one, as it involved the principles of the equatorial telescope and at the same time it antedated it by about ten years.

John J. Watkins, of Lapeer, said he would not willingly detract anything from the claims of Mr. Burt, but he believed that John Mullett had done as much to perfect the Solar Compass as Mr. Burt.

The Secretary said that he had done some work with a son of Mr. Mullett and although he had some talk on the subject had not heard of any such claim. A similar remark was made by Mr. Hollister.

Mr. Hiram Burt said such claims had not been presented to him before, but whatever might be the truth, the Mulletts and the many others would not be forgotten.

NOTE—Since the meeting the Secretary has taken pains to see the heirs of John Mullett who live about nine miles from Lansing.

Mr. Forrester, formerly state engineer, and one of the ablest men in the profession, makes strong claims as to the value of the labors of John Mullett in perfecting this instrument. He was a good mechanic and an able astronomer and spent many years with Mr. Burt in perfecting the Solar Compass. His modest and retiring disposition prevented him from taking any credit. The claim is not made that Mullett originated the idea of the Solar Compass.

THE EXCURSION.

In charge of Prof. C. E. Greene, the members visited the various points of interest on the university campus. They were much astonished at the magnitude of the university and were well pleased with the work done. The forenoon of the second day the members spent in examining the truss built on the T. A. A. and N. R. R. by Prof. C. E. Greene in 1881 and in inspection of the city water works, also built by Prof. Greene. The pumping house is provided with one pair of duplex Knowles pumps most beautifully finished and with a high duty. The water is pumped into a reservoir 185 feet above the principal part of the city and sufficiently elevated to give a fire stream in any part of the city without the use of fire engines. In case extra power is needed the resorvoir can be shut off and pumping may be done directly into the mains.

A vote of thanks was tendered the local committee: Professors Cooley, Greene and Davis.

NEXT ANNUAL CONVENTION.

By vote it was decided to meet for the next convention at the city of Grand Rapids the first week in January 1887.

ELECTION OF OFFICERS.

The Secretary was directed to cast the vote of the society as follows:
President—Prof. J. B. Davis.
Vice President—Geo. E Steele.
Secretary and Treasurer—R. C. Carpenter.
Recording Secretary—H. D. Bartholomew.

After a few remarks by L. S. Alter, Otto Klotz, E. Shreve, the meeting adjourned.

AMENDMENTS TO CONSTITUTION AND BY-LAWS.
(Compiled).

CONSTITUTION.

SECTION 1.—

Any person engaged or actively interested in engineering pursuits, in good standing in his profession, may become a member of this society by paying two dollars into the treasury; provided that all applications for membership shall be endorsed by at least two members of the society and by the executive committee, and further, that each applicant shall receive a majority vote of all the members.

BY-LAWS.

SEC. 2. Amended to read First Tuesday in January.

SEC. 4. Amended to read Two Dollars.

SEC. 6, Article 6, of the By-Laws amended so as to read: "All applications for membership to the society made in accordance with Section 1 of the constitution be acted upon by letter ballot before the annual meeting and that the letter ballot be used in the disposition of all questions which may require the action of the society when not in session, but all such questions shall be considered by the executive committee before being submitted to the society, and all such ballots shall be canvassed by the secretary and reported to the society at the annual meeting."

SEC. 7. There shall be a Recording Secretary elected at each meeting whose term of office shall extend over one year or until his successor shall be duly elected, whose duty it shall be to keep the records of the society and to prepare for the publication of the same. He shall be a also member of the publication committee.

THE CLEVELAND CONVENTION OF ENGINEERS.

There met at Cleveland, Ohio, on December 3d, 4th and 5th, 1885, a convention of delegates from engineering societies of the United States. This convention was the result of a call by the Civil Engineers club of Cleveland, Ohio. It considered the subject of the civil engineering works of the United States. The object of the deliberations was to unite the civil engineers of the United States in a demand that the civil public works of this country be organized into a formal system, both for the purposes of administration and construction. There were 15 accredited delegates representing a constituency of 2,062, ten of whom were able to be present representing 1,656 members of societies. Six other societies were favorably heard from—some cordially endorsing the convention. These societies are scattered very evenly over the whole extent of the country. The representation, while not entirely exhaustive, is as general as could be expected. The proceedings were singularly harmonious and not a negative vote was cast during the entire time of all the sessions. The work was assigned to committees and the subjects discussed very fully and freely. It is a matter of remark that men gathered from such a wide extent of territory should be able to so readily and completely harmonize their views upon so great a subject as to enable them to embody these views in action by the convention for which every one, without a single exception, could heartily vote. The testimony of this fact is convincing that the opinion amongst civil engineers is general that a system of Civil Public Works is imperatively necessary.

The Executive Committee of this society sent your President to represent our interests in this convention. It is but simple courtesy to say that our delegate, and through him our society, was most cordially welcomed and every consideration showed to both. It is a most pleasant duty to record the fact that the hospitable courtesy of the city and state in which the convention was held was most admirably and efficiently sustained by the gentlemen upon whom rested the numberless cares and duties of providing for this gathering. The Cleveland Club is entitled to the thanks of every engineer in the land for its efforts in behalf of this enterprise.

The results of the convention work are expressed in the reports of two of its committees, which reports were unanimously adopted, as above noted. The first of these reports relates to the necessity for a System of Civil Public Works and is as follows:

"Mr. Davis submitted the following report:

To the convention representing the Civil Engineering Societies of the United States, by their delegates assembled at Cleveland, Ohio:

GENTLEMEN:--Your committee on the 'report of the action of the convention, said report to be submitted by the delegates to their respective societies,' respectfully submit the following as their final report:

The foremost nations of the old world have organized systems of internal improvements. The United States at present has no such system. The marvelous development of this great country demands some adequate organization of such a system.

In the formation of such an organization, advantage should be taken of the best features of the system of other nations.

The main reason for the success of such work in foreign countries is due to the fact that they are executed under a civil administration, although the governments themselves, in other respects, are more essentially military than our own.

The distinguishing feature of these organizations is the employment of the best available talent, of men especially fitted by education, training and experience, to design and execute such works.

Under our present methods, the government cannot possibly secure such trained skill. The reason is that no emoluments or reputation, commensurate with the service rendered, or equal to what can be obtained on other civil works, are attained on the public works of our government.

These facts deter men of experience from entering the service of the government, and also those who have gained experience therein, from remaining in its employ.

Recognizing that a comprehensive system of public works is necessary, we respectfully suggest that Congress should be asked to establish a Civil Bureau of Public Works; the basis of organization of this bureau to be made the subject of study and report, by a Board appointed by the President of the United States; said board to consist of seven members, three military engineers, three civil, and one member of the legal profession.

Cleveland, Ohio, Dec 5th, 1885.

J. B. DAVIS,
Pres. Michigan Engineering Society, Chairman.
E. L. CORTHELL,
Engineers, Club of Philadelphia.
CHAS. D. MARX,
Cornell University Ass'n. of Civil Engineers.

On motion the report was accepted and adopted, and the committee discharged.

Yeas. Messrs. Cooley, Eisenmann, Loweth, Kurth, Pence, Davis, Cornell, Varney, Marx and Osmer.—10.

Yays. None.

The second report relates to the methods to be pursued to secure a System of Civil Public Works and is as follows:

"Mr. Eisenmann submitted the following report:

Cleveland, December 5th, 1885.

MR. CHAIRMAN:—Your committee to perpetuate the work and to further the objects of this convention, beg leave to submit the following report:

1st. We recommend that each organization in the United States embracing Civil Engineering be requested to appoint a permanent Committee on National Public Works, and also to empower and direct the chairman of that committee to be a full member of the Civil Engineers' Committee on National Public Works.

2d. Said Committee to perfect its organization and choose an Executive Board of five members. The president of the committee to be president of said Board. Its secretary shall not be a member thereof.

3d. The Executive Board may select from each important city or section of the country one or more engineers as corresponding members of the committee.

4th. Vacancies in the committee to be filled by the society whose seat is vacated.

5th. Vacancies in the Executive Board to be filled by letter ballot of the regular members of the committee, upon nominations made by the Executive Board.

6th. The duties of the Executive Board shall be the dissemination and presentation of the action of the meetings of the committee and other information to the Engineering profession, to Congress and to the country at large.

7th. We further recommend that for the present, the delegates to this convention constitute a temporary committee, and act as such until the doings of this convention are acted upon by the organizations who have apppointed delegates.

Whenever a society takes favorable action, the chairman of the Committee on Public Works of that society shall become the successor of the present temporary incumbent and a member of the permanent committee:—and on the first of April, 1886, the permanent organization shall go into effect.

JOHN EISENMANN,
Civil Engineers' Club of Cleveland.
CHAS. F. LOWETH,
Civil Engineers' Society of St. Paul.
AUGUSTUS KURTH,
Techniker Verbund, (*N. Y. Phil. and Chicago.*"

On motion, the report was accepted and adopted and the committee discharged.

Yeas. Messrs. Cooley, Eisenmann, Loweth, Kurth, Pence, Davis, Corthell, Varney, Marx and Osmer.—10.

Nays. None.

At a subsequent meeting, the temporary Civil Engineer's Committee on National Public Works, was organized with L. E. Cooley, President, and Messrs. Corthell, Davis, Eisenmann and Kurth as executive board.

The recommendations of the convention were adopted, and Wm. T. Blunt elected secretary of the executive board."

Now what this convention desires of the Michigan Engineering Society is, to raise a permanent, or as we call it, a standing committee on National Public Works; to empower that committee to proceed as contemplated in this second report, and to become responsible for its pro rata share of the expense of conducting this movement. It is proposed to distribute this expense equally among individual members of societies, thus making it merely nominal. As an illustration, a tax of fifty cents apiece upon the constituency represented at Cleveland would bring in over $1,000.

Many of the largest and most influential societies have some time since supported the action of the convention, appointed their standing committees, and taken their places in this already national movement. It remains for us to do likewise.

Feeling that the time for action is here, no delay has been made, but the temporary National Committee has been actively at work. Our efficient secretary, Mr. Wm. T. Blunt, of Cleveland, Ohio, has already distributed astonishing quantities of information. Every board of trade, every member of congress and every Engineering Society in the United States has been communicated with, as well as numerous prominent members of the profession. Besides this, our president, Mr. L. E. Cooley, of Chicago, Ill., has labored with equal faithfulness, among many other things, having produced a very exhaustive paper upon one branch of this subject and therein amply demonstrating the main proposition, namely, the necessity for a system and for a comprehensive administration of our National Civil Public Works. Others have been very active, notably, Mr E. L. Corthell, of New York, who has given this matter the same earnest and devoted attention that he is so well known to apply to matters which deeply interest him. So I am able to inform you that the work has been pushed at every available point and that it is deeply interesting many influential persons.

ISTHMUS SHIP TRANSIT.

There will be brought before the country and congress this winter the question of ship transit across the American Isthmus. The importance of this subject needs no advocate here. The scheme for its accomplishment is of the utmost consequence to us as Americans and also as

engineers. It is of consequence to us as Americans that our national peace be not jeopardized by any changes introduced into our foreign relations. It is also of consequence to us as Americans that this great American commercial line of communication should be thoroughly and completely American. It is of consequence to us as engineers that this—one of the mighty engineering enterprises of the age—should be most creditably done, and that it should reflect renown and not dishonor upon our profession. It is therefore a simple duty for us to know what we can about all phazes aud features of the different plans, both as American citizens and as engineers. While modesty especially becomes the men who have to deal with the facts and principles of nature, as we do, and we may not properly hasten to our conclusions upon such a great matter as this--still, on the other hand we are not thereby released from our duty of knowing the world's greatest thoughts within the bounds of our professional horizon.

The foreign enterprise of a tide level ship canal acoss Panama seems in a fair way to make a speedy and probably disastrous conclusion. This has been confidently anticipated from the very first. It could be safely predicted from the plain disregard of certain well known simple financial principles. Unless this is all reversed, but one certain result can be anticipated—that result is the one alluded to above. That seems fast approaching.

Of the other numerous and varied schemes of modern times, but two at present appear to remain--the Nicaragua ship canal, with locks, and the Tehuantepec ship railroad. Both of these are likely to appear before congress during its present session.

It is not within my province here to discuss the merits of these two plans. But as Americans and as engineers I respectfully suggest that you diligently inquire and see, if you have not done so already, which of them is entitled to your favorable consideration regarding the following principles: Which makes the most definite demands? Which involves us as a nation in entangling foreign alliances? Which presents the superior engineering difficulties? Which involves the greatest number of unknown elements in its construction? Which presents the greatest facilities for enlargement? Which is nearest to the great axial lines of our own and foreign communication? Which makes the best proposed return to our own government for its outlay? Which will benefit our nation most? Which is most easily defended in war, should need be? I shall take pleasure in joining in a discussion of any or all of these questions, and it would please me to see recorded in our proceedings an expression of opinion upon this great question, should the members feel ready to make such a record.

RAILROADS.

I especially call the attention of the members and so far as necessary, the attention of the public, to the matter of railroads in this state.

The past year has witnessed many efforts on the part of the railroads, despite the close times and small or minus dividends, to improve their service. There is a manifest disposition to work up to the lines of our member, Mr. Treadwell, which he so admirably set forth at our last convention, in the matter of a perfect roadbed as fast as practicable. But we need to recollect that many other things call upon the attention and funds of our railroad companies. There are station buildings, bridges, improved freight service and increased speed of passenger trains as a few of the demands upon them. We now have some very high speed trains in this state, trains that not unusually run a mile a minute. Of the demands upon the perfection of railway systems made by such a train service, I will leave our railroad members to express themselves.

But while the public demands the things referred to, and gets them, some other things equally important for its convenience and safety, as well as for economy in the operation of the railroads and an increase in their income, wait for attention. Some of these I will name.

1. The railroads should make possible connections at all railroad crossings and junctions. There should be facilities at such places for the transfer of passengers and baggage. The public should require this reasonable service in return for the franchises granted the corporations. The railroads should do it of their own will to increase their income and get paid for the expense of a stop at every such place, now required by law. I have been surprised at the amounts of such transfers when made late at night even. If one of the very fastest trains in the state can afford this service it seems that the rest might. However, the public should see to it, that it is not a sufferer from the petty business spite of corporations who "won't." That is, they had rather lose a considerable sum annually than connect with a rival road.

2. Neither the public or the railroad companies should permit another grade track crossing to be built in the state. The public should not permit it for protection. The railroad companies should not permit it for economy. I doubt if there is a grade track crossing in the state, outside of cities, that will not pay a handsome dividend to both companies upon the cost of alteration if they will be anywise accommodating and reasonable with each other in making the change. Let any company make a very simple calculation of the cost of stopping trains at a crossing for a year, and see what a sum that will be the interest upon. They will find that a large expense at these places, even if it does not give very good grades, will be profitable.

3. Following the grade track crossings, the grade highway crossings outside of cities and villages should be gradually removed. Those in

cuts and on curves should be improved first and then the others, as fast as it is at all practicable. This needs no argument—a single death, and we have scores—is enough. I have no doubt that if the civil authorities will meet the corporations in a friendly spirit this deadly evil can be rapidly overcome. The cattle-guards and the care of these places will go some ways with the companies in abolishing grade highway crossings. Let us all use our influence as citizens, as engineers, and as railroad men to accomplish this.

This year the railroads in this state are required by statute to adopt safety freight car couplings. There have been several trials of these devices, notably the one in Buffalo, in September. There has been great activity amongst inventors in this line. The coupling patents have been issuing from the patent office for a year back at the rate of about one a day, and I believe there are some thousands of them now. All roads doing business in this state must employ them by July 1st, next. While this is not the time and place to discuss this subject I take occasion to say that it seems probable that the old link and pin coupling can be made both automatic and safe, as it is. This fact may be of service during the transition period but should not, I think, be depended upon for a finality, on account of necessary complications. I hope the members may have an opportunity of seeing one of the most serviceable, and so far sensible, of the new couplings, while here, namely, the Morgan coupler.

BUILDING INSPECTION.

I would respectfully call attention to our building inspection statutes—so much unobserved. These laws will be found in Howell, Sections 2,095 to 2,102 inclusive, and in Public Acts for 1883, 170. Without going into detail I will simply say that these laws require building inspection everywhere in the state, country as well as city, that this inspection must cover condition of building, its safety as a place of occupapation and the means of safe and speedy egress therefrom in case of alarm. These statutes apply to all that are ever used as places of public assemblage, such as halls, churches, school houses, theatres, rinks, dancing halls and the like. Yearly inspection is required. Hotels and places of assembling work hands above the second story must have fire escapes. The authorities and inspectors are required to act and their duties are specified. The building must not be used for the purposes named in the statutes without an inspector's certificate, otherwise the parties interested in such use are subject to a fine for a misdemeanor of not less than $100 nor more than $500, or imprisonment in the State House of Correction not less than 90 days or more than one year, or by both. To engineers and constructors in this state these laws are of the utmost consequence, yet out of the large cities little attention appears to be paid to them, and in the country none. They are mandatory in character and

need our earnest attention. Are station buildings under the contemplation of this law?

WATER SUPPLY.

The development of water supplies for cities in this and other states, similar in topography and geology, goes steadily on. It is a gratification to be able to say that the special necessities of this problem, presented in many of our western states are being so actively met by members of our own society. While the methods being adopted are not by any means new, the special applications of them are of the most interesting and varied character. It seems certain that the people of these states can look hopefully to the water bearing strata about them for liberal supplies of the best of water. We all recognize the superiority of this source in point of prospective purity over any surface source. You will be supplied with information and experience upon this subject during your session and I will therefore refrain from saying more about it.

PERFIELD'S TAPE REEL.

During the winter of 1885 I had a reel made for heavy steel measuring tapes of Mr. Hodgman's manufacture. This reel was made by Mr. Henry M. Perfield, of Ann Arbor. It is so well adapted to its use that I venture to direct your attention to it with the utmost confidence. I will speak of a reel for 100 feet of Hodgman's heavy steel tape.

1. It weighs six ounces.
2. It carries 100 feet of steel tape.
3. It goes in a side coat pocket with the tape on.
4. It will go in most any common pocket with tape off.
5. It is composed of four parts.
6. It leaves the wound up tape open to dry.
7. It retains the tape without fastening in any way. Wind up and quit.
8. It is of ample strength, and size, and of convenient form and arrangement for easy use with or without mittens on the hands.

I am confident we now have a reel to match the Hodgman tape in utility. We now have a perfect measuring apparatus for general use.

This reel can be adapted to any size of tape made of any width or kind of material.

REPORT OF STANDING COMMITTEE ON MANUAL.

The committee on Manual esteem it proper, now that the work is completed, to embody the substance of the several verbal reports which have been made by the committee, in form so that they may reach every member of the society through the medium of its published proceed-

ings. The original idea of the Manual contemplated simply the production of a book which should contain the existing land laws, instructions and decisions of courts on points relative to the surveyors practice. With this idea in mind the committee collected a large amount of matter embracing in its scope all the decisions of the Supreme Court, of the United States and a large proportion of the decisions of the Supreme Courts of the several states on points having a direct bearing on the surveyors work in the field.

It was found that many of these decisions covered, practically, the same ground and that by careful selection the space occupied by them might be very materially reduced without omitting any important principle, and at the same time making the work more terse and clear.

The statutes of the United States relative to government surveys were collected as well as the varied instructions issued from time to time to the Surveyors General of the United States directing the manner in which these surveys should be carried on, and such portions of them as seemed to have a bearing on the surveyors practice at the present time, were selected for publication.

It soon became evident to the committee that a large part of this matter belonged as properly in the text book for the student as in the book of reference for the surveyor. It was a matter of surprise that no text book had been produced which taught these fundamental principles which must govern the practical work of the surveyor in the field.

The question of publication also had to be considered and the probable sale of the Manual when published. On looking over the field it was found that the number of surveyors who would be likely to purchase such a book was small—so small that they did not support a professional paper devoted specially to their own interests. The list of surveyors in the latest number of the American Register which endeavors to give as full a list as possible for the United States, contains less than 2,000 names. These considerations led to the belief, on the part of the committee, that in order to have the work pay the cost of publication and be furnished to the society at a reasonable price, its field must be extended, and that the way to do that was to place it in the hands of the student. Through the force of these considerations Prof. C. F. R. Bellows became connected with the work and a member of the committee. It was decided to make the Manual a complete text book for the student of Land Surveying. To that end a mathematical treatise has been prepared and incorporated in the work. Such tables as the student would need in the solution of his problems and the surveyor would need in his every day practice were introduced. The committee were well aware that there are many surveyors who are provided with tables and mathematical treaties on surveying who do not care to pay for them again; but they hoped by including these things to so extend the scope of the work and increase its sale that it could be furnished at a price little if any above what it would have cost to furnish the Manual without them, while to many other sur-

veyors and to all students of land surveying it would furnish just the complete work they needed. The committee have scanned carefully the reports of various Surveying Associations; have attended their meetings, listened to their discussions and gleaned from them many things which seemed desirable to incorporate in the Manual.

The publication of the book was attended with unlooked for and unpleasant delays and its cost far outran the expectations of the committee. This increased cost came chiefly from the increase in the size of the book which contains fully double the amount of matter at first contemplated, a large portion of which—the tables, is the most expensive part. It was at last completed, and has met a very cordial reception from the surveyors of the country and from the engineers and educational press. It is a duodecimo volume containing 364 pages of text and 100 pages of tables. It is bound in morocco in the form of an engineers' pocket book, with folding cover but without tuck. Its retail price is $2.50. Since its publication it has been officially endorsed by the Missouri Association of Surveyors and Engineers and by the State Department of the State of Iowa. The following is a partial table of contents:

SECTION I.—INTRODUCTION.

Logarithms,
Trigonometrical Formulas,
Solutions of Triangles.

SECTION II.—DEFINITIONS AND PLATTING INSTRUMENTS.

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By arrangement with the Society, Prof. Bellows and Mr. Hodgman of the committee assumed the responsibility of the publication and are to receive the proceeds therefrom. They are to pay back to the Society the sums which it has expended in paying the expenses of the committee while engaged in preparing the work. They are to furnish the Society the Manual at an advance of twenty-five per cent upon the cost of publication based on an edition of 1000 copies. The Society, on its part, agrees to take 300 copies of the Manual and to aid in every way possible the sale of all published. It seems very desirable to the committee that the members of the Society, who have not already done so, should send in their orders as soon as possible to assist in meeting the heavy bills for publishing the first edition of the Manual. The members of the Society have already been notified of the terms upon which it is furnished to them.

Great care and pains was taken to have everything about the work as accurate and correct as possible, but the committee is well aware that errors, typographical and otherwise, often escape the closest scrutiny, and that the Manual is no exception in this respect. Several such errors have been already discovered, and the committee will deem it a favor if those into whose hands the book may fall, will report such errors as may fall under their observation. We hope that the Manual will reach a sale of more than one edition in order that those engaged in its preparation may reap some small reward for the time, labor and money spent

upon it. We desire to keep it fully up to the times and to make it meet, as nearly as is possible in such a work, the wants of every student and land surveyor, and we desire that the profession will confer freely with us in order that we may make it best meet the wants of the greatest number.

F. HODGMAN, Climax,
G. E. STEELE, Traverse City,
C. F. R. BELLOWS, Ypsilanti.
Committee.

PLATS.

AS PRESENTED TO THE AUDITOR GENERAL FOR APPROVAL UNDER THE AMENDMENT OF MAY 21ST, 1885.

BY H. D. BARTHOLOMEW,

LANSING, MICH.

I appear before you at this time as the attorney for the public versus the surveying profession, in the matter of city plats, and incidentally versus the proprietors and legal profession where they have undertaken to interpret the law.

My plea is based upon my experience as special examiner of plats in the Auditor General's office since the 20th of last June, which has required from one to five days time each month, and most, if not all the the plats presented since that date have been before me.

The questions raised have covered nearly every separate clause of Sections 1473 and 1474, of Howell's Annotated Statutes. I have felt like exclaiming as did the mailed knight in Ivanhoe after he had been a short time target for the bolts of Robin Hood and his followers: "They have hit every nail in my armor."

The object of my paper is not to hold up to your view an ideal perfect law, such as I, mounted on my hobby, would wish to see on the statute book, but rather to give the facts as they exist under the present law, showing the opinions expressed in acts or work by the profession, propietors and lawyers called in to give advice under the law.

Instead of being a thing of beauty it will be a record, shall I say plainly, of want of information, misapprehension, want of study and thought, with a full quota of blunders and mistakes, which should be avoided.

If I should succeed in interesting you I may make bold to ask for some action looking towards a greater uniformity, urging you to adopt or recommend some simple forms.

The first plat filed in the Auditor General's office was on July 29th, 1873, and the last No. 1870 was filed January 22nd, 1886, being an average of about 150 per year. Since the passage of the amendment approved May 21st, 1885, 105 have been filed, which includes those that have been properly recorded by the register of deeds, prior to the passage of the amendment.

One was recorded that was executed in 1873 and recorded in 1874.

The above number does not cover those returned for non-conformity to the law.

One surveyor, claiming twenty years practice, asked what he should do with a cemetery. Another of thirty years' standing enquired how to dispose of a summer resort on the lake shore. These are not mentioned in the law. The answer was, that all parcels of land, which are to be described in the deeds by other methods than that by the United States description, or by metes and bounds must be considered as plats under the law.

QUERY. If a municipality owns the cemetery and it is not subject to taxation, is it necessary to record and file a plat?

It has been generally considered that Sections 1476 to 1479 inclusive, prescribed the manner in which plats must be altered, as well as vacated by the courts, but under the present ruling a plat can be amended or altered by filing a new one, the title declaring that it is an amended plat.

QUESTION. Can a proprietor take up a street that has been dedicated to the public and parcel it into lots by filing a new plat?

The scale showing not more than two hundred feet to an inch, appears simple, but in practice, it has been a very troublesome matter. Some give no scale at all; some three hundred feet or more to an inch; some give it in the written description without diagram; some a diagram only, without explanation. A few who believe in a variety give a diagram with a unit of chains, a written description in rods, with the distance on the plat in feet. The lovers of hash, however, give us a chain at one end of a lot, rods at the other, and feet at the sides; while one made the discovery that the north side of a certain lot line was two chains and twenty links long, and the south side of the same line was one hundred and forty feet in length, a variation in the two sides of the same line of five feet and two-tenths.

Wherever the law gives explicit directions, no matter how trivial and unimportant they may appear, they must be obeyed, for is it not an old principle, that he who breaks a law in the smallest part is guilty of breaking the whole law?

There should always be a true diagram of the scale used, with a written explanation below, or above it. It would also be well to give the scale in the written description. It is certainly required by good taste, if not by the law, that you select your unit, feet, rods, or chains, and only let that unit appear on the plat.

One or two plats were rejected because they were not of the regulation size, and could not be filed in the same book with the others. The plea made for the large size was the same as for the scale of 300 feet to the inch. It could not be got on one sheet without making a change, forgetting, or not knowing, that the plat may be divided into two, three or more sheets.

In designating the cardinal points, two or three points may be noticed.

Comparatively few give the variation of the needle, while some who do give an angle of 8 or 10 degrees and make it one, or less. One or two marked the diagram at the top, say 2° varying to the east, and the bottom 2° varying to the west. Can the needle vary both ways at once?

In some of the most elaborate diagrams, quadrated circles, the east and west line is made at right angles with the true meridian, in others, at right angles to the needle. Which is right?

The greatest latitude is permitted in the written descriptions. In the oldest part of the state where private claims, concessions and out lots are accepted by the courts as government descriptions the full title is often the only written description, the names of the surveyor and proprietor appearing elsewhere.

Where the plat is to cover but a small part of a government description it becomes necessary to give, not only the township, range, section and part of section on which the plat is located, but also to define it by metes and bounds.

Here is exhibited the greatest lack of study and forethought in selecting the initial point of the survey and the guide, or monument from which to find it. Too often the guide is some highway, Rail Road track or right of way or other movable object, from which you run half a dozen zig zag courses, half around the ground to be platted to the initial point.

Others go to the other extreme and declare the initial point to be a corner of a lot or block yet to be platted, saying in effect that you will find the initial point when you come to it, or you will come to it when yon find it. Others again, think it is a written description of the plat when finished, detailing the sizes of the lots, blocks, streets and other minutia. The law says explicitly "a full and detailed description of the land embraced in said plat," that is a survey bill of the land before it is platted and should contain no reference to the plat whatever. In fact it should be just such a survey bill as you would put into a warranty deed, no more and no less.

The initial point should be the one nearest to, or in the most direct line from the nearest government corner, or line, and should be found by making but one angle from the monument north or south and east or west.

After the written description or survey bill, there should be a few specifications giving the scale, variation of the needle and all necessary reference to the plat which is yet to be made, especially the description and location of the monuments.

Then should follow what might be called the dedication, containing the declaration of ownership, having caused the survey and execution of the plat, the name of the plat, dedication of the streets to the

public, closing with a joint certificate with the surveyor that the plat is true and correct, according to the said survey.

Many reading the law understand that one of the specifications should give the names of the proprietor and surveyor with date of the survey. The Auditor General does not require this, claiming that the signature of the propietor and surveyor with witnesses and acknowledgement as required for deeds conveying land is sufficient.

The next clause of the law is very generally misunderstood. "The sections and parts of sections platted shall also be designated by lines drawn upon said map or plat and shall be marked with appropriate letters and figures." In many plats with excellent written description, locating the land exactly, you cannot tell from the plat itself, the section, town, nor range in which it is located. And when the attempt is made to connect the plat with the written description, very often the designations, letters and figures used, are not found nor are they referred to in the written description.

For example, a plat is received with the title, Subdivision of Lot A, John Doe farm. This is the entire written description. The block is bounded on each side by a street. No boundary line of the original Lot A is given. The plat is returned to have its boundary designated. The plat comes back with the interior lines of the four streets marked as the north, east, south and west lines of said streets. This excludes all streets from the plat, but makes no reference to Lot A. The certificate of the owner, however, dedicates the streets to the public. Another letter is written, or the plat is again returned to know what streets or parts of streets are dedicated. We then learn that two feet of the first street, eighty feet of the second, thirty-five feet of the third and fifteen of the fourth, are included in the original Lot A. Had the surveyor drawn first the boundaries of Lot A as he found it, and marked them as the north, east, south and west lines of Lot A, he would have had a plat consistent with itself and told what was necessary. Another common error is to give the lines on the plats a different course from that given in the written description. A line given in the survey bill as N. 89° 15' E. is platted as Sec. 89° 15' W. You say he has reversed the courses. Not so, for he gives two southerly and two westerly lines, but no northerly or easterly lines. One plat was submitted with six or eight boundary lines, all of which were marked northerly, except one and that was southerly. The outline of the plat should be a verbatim copy of the written description, giving initial point and indicating the government corner referred to as a guide, so that a stranger looking at the plat alone, can write out a correct survey bill.

Section 1474 should be brought in here as it describes how the plats should be filled out, with street, alleys, lots, blocks and public grounds, their dimensions and if the streets do not run parallel with the boundaries of the plat, their course should be given.

When the lots are gores, triangles or irregular in shape, all the dimensions must be given to every lot and when three lots join two, or two short lots, and the dead end of a street join two long lots, the full length of the boundary line should be given in that lot to which it pertains. Some seem to think that this direction in the law, merely requires them to indicate by some sign that the lots were not of the same size, without giving the exact size. One plat was presented with a series of lots marked 66 ± with a note saying they varied in size. The south course was given the same as the northern with the addition of the ± sign, with the information in the note that the two lines were not parallel.

One plat was submitted with the names of the streets printed on slips of paper which were pasted on the plat. One of these began to curl up before the examination was completed and as, from the prescribed manner of filing, the surface of the plats are subjected to considerable friction, the plat was not opened. Also all attached certificates of verifications are rejected.

I would here call your attention to one point not mentioned in the law.

When blocks are subdivided or re-platted, varying the number or location of lots, the lowest number of the new plat should be higher than the highest of the old in order to diminish the chances of error, in the assessment rolls and deeds of the property.

The city of Ann Arbor boasts of being laid out in the most perfect and scientific manner of any city in the state, but yet the list of her delinquent taxes received at the capitol annually, contains as large, if not larger, per cent of errors in the descriptions, than those received from other places in the state

The ordinary supervisor or assessor will not, or cannot accurately copy the four parallel series of numbers with the distinguishing letters.

The question of the non-resident surveyor or notary, that some find in the last clause of Sec. 1474, the department ignores, claiming that the first requirement, that plats shall be witnessed and acknowledged as deeds are, is all that can be required.

An affidavit of correctness by the surveyor cannot be received in lieu of an acknowledgement.

All certificates required by law, must be an exact copy of the requirement, *verbatim et literatim*, as far as may be. The omission of the word separately, from the certificates of comparison, has caused the return of many plats.

The clause giving the Supervisor of a township authority to make and file a plat, when authorized by the township board requires some attention.

He can make a plat the same as if an owner, only citing his authority and purpose and omitting the dedication of the streets, or he can unite with the principal owners and thus number all the small lots that have been sold by metes and bounds.

The board cannot however, as some seem to think, under the law require or request the owners to make a plat and let the town pay the expense.

One firm of lawyers insisted that the Auditor General should approve both the original and duplicate, for otherwise, they argued, it would not be a duplicate.

They forgot that our Legislature is as powerful as the boy, who on a cold winters night could sell "hot mince pies" even if they were frozen.

Another firm labored long with the department, claiming that it was putting their clients to a needless expense by requiring them to give the dimensions of the north and west tier of lots on their plat, as it would compel them to send a surveyor on to the ground up in the pine woods, and run out the forty.

A Register of Deeds wrote a long letter begging the Auditor General to receive the original, or if he preferred it, the duplicate, to place on file as the owners did not wish to pay for a certified copy of the record.

Heirs to an estate have thought to cheapen the expense of settling the estate by platting it. In one case they placed in juxtaposition two tracts of land, separated by a mile and a half, with a village lot taken from some unknown locality. The Attorney General has ruled that you cannot plat under one title distant parcels of land.

Owners, who after selling several parcels by metes and bounds, promising the purchasers a street, are threatened with prosecution under Sec. 1475, make a plat covering all the lots sold, but as this is clearly contrary to the letter and spirit of the law, all such plats are rejected when known.

Several plats were received, which on their face appeared to have been changed by the owner after the surveyor had completed his work.

By so doing a question in metaphysics was raised. A heavy black line was drawn through the lot at the southwest corner of the plat, which had been numbered 4, and the written description was amended by inserting the words "except the south half of lot 4." How can you except that which never existed?

If the south half of lot 4 is not platted, then the south half of lot 4 never had any existence.

All exceptions to a plat should be given by metes and bounds, in the written description, and the parcels on the plat should be marked "excepted."

The variation between the old surveys on the Detroit River and the government surveys has caused many failures, and some scolding. Some of the best surveyors in Detroit, who have made many plats in the city, go to the country for that purpose, but with hardly an exception the plats are returned for additional data. In one or two instances, they apparently threw up the work and others made the plat.

Another trouble has been that some of our best representatives had copied a form prior to the amendment and having but one or two plats in

a year, they did not notice or appreciate the changes, and when their plats were returned for more data, they took it ill, claiming that the Auditor General assumed more powers than the law intended. One of these protested against giving the courses of the boundary line, as no two needles agread and every needle varied from day to day, and from hour to hour each day. Would he but heed the pleadings and advice of our worthy President, and set down monuments, he need not trouble himself about the needle, for what surveyor is there, if he can find well attested monument cares much for the courses or distance.

Some owners discovering that a portion of their boundary lines are disputed, are indefinite or doubtful, have sought to file a plat to strengthen their title, leaving some of the lines doubtful or undetermined. The department has ruled that the phrase "a full and detailed description," means a definite and correct one.

One or two plats were submitted bounded on one side by a curve which the surveyor had given as a direct course, apparently not understanding the railroad engineer's manner of defining a curve. As a railroad caused the curve in one instance the surveyor was asked to give that course as along the westerly side of the railroad right of way a certain fixed distance.

A clerical error called my attention to one point that should be always tested, but is very rarely noticed.

The surveyor, before commencing work called for the deed and noted the courses and distances. After making the survey he compared, and found that on one of his distances he did not agree with the deed and noted this discrepency in his written description. In making the plat his distances gave a different sum from either the deed or his survey. The plat of one of the additions to the city of Lansing, covers over one rod in length more than the written description calls for.

Passing by the many clerical errors and such simple ones as making the original, that the Auditor General has approved into the certified copy, or the sending him the original or duplicate to place on file, I would call attention to the plat when ready for his approval. It should be in the same state, as when under the old law, you gave it to the Register of Deeds for his certificate of record. That is, it should contain all that is called for by Sec. 1473, to the clause referring to the record, and all of Sec. 1474 that is applicable to that plat, duly modified if a supervisor is interested therein.

Most of the decisions of the Auditor General, concerning the execution of plats have been well received, and quietly acquiesced in, but some have been criticised, protested against, and contested by arguments and pleading, and if this paper is not criticised and questioned, I shall feel hat my labor has in a great measure been lost.

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of MR. HODGMAN It seems to me this paper ought not to pass with-
ome discussion. Mr. Bartholomew has shown us the defects in

many of the plats sent, and it is to be hoped that in future better work may be done. But while conceding the fact that many defective plats are sent to the Auditor General for approval I am equally certain that many perfect plats are sent back to the maker to have defects corrected which exist only in the imagination of the Deputy Auditor General or the man who inspects the plats for him. The evils complained of under the old system by Hon. Geo. E. Steele at our last meeting, (see reports of 1885), have been aggravated and intensified under the present system.

Plats are frequently rejected for similar and more trivial reasons than those mentioned by Mr. Steele. I sent in one plat in which the description started from a stone in the quarter line, 22 chains distant from the quarter post. The location of the stone and its distance and direction from the quarter post were marked on the plat. It was rejected because the entire quarter line and quarter post, (which was 22 chains away from the nearest point of the plat) were not marked on the plat. Another plat starting from the same stone, and described in the same way, without the quarter line and post being marked on the plat, had no fault found with it on that score, but was rejected for a reason having just as little weight as the other.

The law requires a full and complete description of the land platted, to be written on *the paper on which the plat is made.* It nowhere requires this description to be written along the lines of the plat itself, and yet plats have been rejected time and again because that description was not written out twice and the East side of the plat marked *North*, the North side *West* and so on, to correspond with the description elsewhere written out. Now I call it an outrage to reject plats for reasons no better than these. They are not in the law. They are not down in the instructions issued from the Auditor General's office. If the Auditor General would issue a circular, giving in detail those points which he will require in the execution of the plats, I for one would be willing to abide by them and do my best to fulfill the requirements. But I shall not be put to the expense and delay of sending plats back and forth for reasons no better than those I have mentioned -which are contained neither in the law nor the instructions -without kicking.

A number of other members stated that they had had similar experience in getting plats approved.

MR. BARTHOLOMEW--I move that a committee be appointed to draw up recommendations relative to the details of plats, of which Mr. Hodgman be chairman. I have been employed more or less by the Auditor General to examine plats and I think I can safely promise that such rules and recommendations as may be adopted by this society will receive the approval of the office, and a new circular containing them will be issued and distributed throughout the state within the ne three weeks.

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MR. HODGMAN—I second the motion and move that Mr. Bartholomew be also a member of the committee.

The motion was carried and Messrs. Hodgman, Bartholomew and Watkins were appointed such committee.

They made the following report which was unanimously adopted:

Your committee to whom was referred the question of requirements for village plats, would respectfully report that they have had the same under consideration and would recommend that in order to secure uniformity of practice in making village plats, that the surveyors of the state in making such plats, observe the following points in connection with and supplementary to the instructions contained in the circular from the Auditor General's office of May 29, 1885.

1st. That the written description of the land platted should be clear and distinct, describing it in as brief a manner as is consistent with accuracy, so that there should be no misunderstanding as to what land the plat is intended to cover. That the outlines of the plat itself shall be marked with appropriate letters and figures corresponding with the written description, indicating the courses and lengths of those lines. That if any lots lying within the outlines of the plat are not intended to be considered a part of the plat they should not be numbered or lettered, and the fact that they are excepted be noted in the written description. The courses and lengths of the lines of such lots should be marked on the plat by appropriate letters and figures, and the lots themselves marked on the plat as excepted.

2nd. Use a short and simple form of acknowledgment something like this:

STATE OF MICHIGAN, } ss. On this.....day of.....before
COUNTY OF..... }
me a.....in and for said county, personally appeared
.....(Owner or Supervisor,) and.....
Surveyor, who are to me known, and by me known to be the persons who made and executed this plat of..... and who severally acknowledge the same to be their free act and deed.

3d. Use but one unit of measurement on the plat. Make a diagram on the plat of the scale used with appropriate letters to show what the scale is.

4th. The cardinal points to be indicated in a simple manner by a narrow or fleur de lis, with appropriate letters. This we understand to be intended only to indicate in a general way the four points of compass on the map. Wherever practicable give the courses in the written description and on the plat from the true meridian and also when practicable that the angles of intersecting lines be given in the plat.

5th. That it should be remembered that Sec. 1474 of the law H. A. S., is to be considered in connection with the fifth clause of Sec. 1473.

6th. That we esteem it of first importance that permanent monuments be located in the ground at all important points in the plat, and that the character and location of such monuments with their bearing trees or points be distinctly given on the plat.

F. HODGMAN.
H. D. BARTHOLOMEW.
J. J. WATKINS.

THE LANDS WE SURVEY.

GEORGE E. STEELE.

1. Possession and Title.
2. Early Grants.
3. Planning the Public Land System.

This paper is designed more especially as a preparatory one, to show how, by successive steps, the present government system of surveys came to be adopted; and to mention the first title and early possession of the public domain. It may be followed by others more specific, upon the same subject.

The primary acquisition of territory, and consequently of allodial rights, is of very little thought with the average American. His "squatter sovereignty" is his own enactment, put into execution with the axe, hammer and plow—ever ready implements of industrial warfare. The principle of "free soil for free men" is no where better illustrated than in our own government. No feudal tenure is compatible with it. The holding of estates should be without the interferance of the King. In other words –let every man be his own landlord. The earliest proprietary rights are obtained by conquest.

Caracalla said "so long as my sword remains I shall want no money."

Tyre, is only a toy in Alexander's hands. Columbus stepped on the shore of the newly discovered land and raised the royal banner of Castile, naming the island San Salvador. Balboa crossed the isthmus and discovered the Pacific, and "pompously drawing his sword took possession of it in the name of the King of Spain."

Cartier "set up a cross bearing the shield with the lily of France, and proclaimed the French king monarch of the country."

These are examples of discovery, you say, but subsequent events proved there was a power already on the throne and only conquest could maintain discovery.

Thus has the world been oscillating between contending armies, and with blood has been written all over the eras of the past, the principle that "to the victors belong the spoils."

Gradually has a better principle been evolved. At first the Indian title was considered one of occupancy, but as the rights of the native people came to be recognized, nations have been more willing to extend their possessions by treaty or purchase. And when such title is extinguished either by *Conquest, Treaty or Purchase*, the right to grant in fee,

the absolute title to the soil by those European nations obtaining dominion is not questioned.

What then is this title? Confining our answer to our own form of government, it is a sovereign ownership in the people belonging to the government, until alienated by them through their legally appointed officers.

To more fully establish this principle, we quote from William Prynne on Parliaments—1643.

"The court of Parliament hath a lawful power to question all the Kings patents."

Ib. "That Emperors, Kings, Princes, are not the true proprietary lords or owners of the lands, &c., of their Empires, Kingdoms, to alienate or dispose of them at their pleasure, but only the guardians, trustees, stewards or supervisors of them for their kingdoms, use and benefit, from whom they cannot alien them, nor may without their consents or privities lawfully dispose of them to the public prejudice, which if they do, their grants are void and revocable.

Ib. "Kings cannot mortgage the patrimony of the Crown."

This reasoning, with Prynne's other bold espousal of popular rights, cost him both his ears and long years of imprisonment, but it is just as good Puritan doctrine now as ever.

It has been substantially agreed to in the United States from the first confederation, and in holding all the vast territory ceded to it by other powers, this government has been but the steward of the people. Every government grant by letters patent shows the Act of Congress by which it was made, and authorized the Chief Executive to execute it in accordance therewith. Except the original thirteen States and Texas, which entered the Union as landed proprietors, and some other exceptions the title of the soil was in the general government.

EARLY GRANTS.

King James I. issued two patents to men of his own kingdom April 10th, 1606, the one to the London Company of all the region between the 34th and 38th degree of latitude, and the other to the Plymouth Company, between the 41st and 45th parallels; thus separating the two by the space of three degrees of latitude. Subsequent events have proved that King James did not separate them far enough. We hope though, the members of our Association may live long enough to see the North and South cemented by the ties of education, commerce and industry, guided by the skilled Engineer to transmute their undeveloped resources into the elements of prosperity and peace, National Public Works.

The second Charter was in 1609, and the third in 1612. During these years, and while the original colonies were dependencies of royalty, various charters were given, or amendments made to them—all of them more or less, setting aside the sovereign ownership and political liberty

we have before mentioned, and especially securing great powers to the crown. Afterwards, when the colonies became restless under such repeated usurpations, the grant of land actually made by the crown was respected, except where confiscated for disloyalty to the Confederation. In the general uprising against the tyranny of the mother country which culminated in the Declaration of Independence, the Congress of the Confederation granted unappropriated lands in some of the States to those foreigners who would leave the armies of His Britanic Majesty in America and become members of any of these States. The amount was fifty acres each, by Act of Congress August 14, 1776, and one hundred acres each, by Act of August 27, and September 16, of the same year, to soldiers and non-commissioned officers. This Congress did not provide for disposing of these lands by deed till May 20, 1775, when it would seem that its title was somewhat questionable, not having been ceded to the United States by the Crown.

But when the States became cemented by the Constitution and recognized as a separate Nation, the Acts of Congress confirmed the promises made by the Confederation, by the issue of Bounty Land Warrants and Patents for lands with that absolute and exclusive title which has never been questioned in our courts.

PLANNING THE PUBLIC LAND SYSTEM.

In the secret journals of the Congress of the Confederation, October 15th, 1783 the Indians were informed "that after a contest of eight years for the soverignty of this country, Great Britain has relinquished to the United States all claim to the country within the limits described by the second article of the provisional treaty between the United States and the King of Great Britain, on the 13th of November, 1782, that they were to be proffered clemency instead of rigor, and although they had joined the British, a veil was to be thrown over the past and a Boundary Line established between them and us." And the 19th of March, 1784, Messrs. Jefferson, Howell and Williamson report in favor of a Meridian line passing through the lowest point of the rapids of the Ohio to the Northern boundary of these United States which shall be proposed as the line of division between the several Indian tribes and the States. (Secret Journals of Congress, Domestic Affairs, 1775–88, page 261.)

This was the first faint outlook upon the vast territory which had been acquired and only a glimpse of what must be done in surveying and disposing of it.

On the 17th of May, 1784, an ordinance was reported "for ascertaining the mode of locating and disposing of lands in the western territory" which was considered, discussed and amended until the expiration of more than one year from its introduction, when it finally passed on May 20th, 1784.

As uncommon interest attaches to this early Act, we give it nearly entire. There are some points not found in other Acts.

"An odinance for ascertaining the mode of disposing of lands in the Western Territory."

"*Be it Ordained, &c.*, That the territory ceded by individual States to the United States which has been purchased of the Indian inhabitants shall be disposed of in the following manner:

"A Surveyor shall be appointed from each State of the Confederation. The Surveyors as they are respectively qualified, shall proceed to divide the said territory into townships of six miles square, by lines running due North and South, and others crossing these at right angles as near as may be, unless where the boundaries of the late Indian purchases may render the same impracticable, and there they shall depart from this rule no farther than the particular circumstances may require. The first line running North and South, as aforesaid, shall begin on the Ohio river at a point that shall be found to be due North from the western terminus of a line which has been run as the south boundary of the State of Pennsylvania; and the first line running East and West shall begin at the same point, and shall extend throughout the whole territory. Provided that nothing herein shall be construed as fixing the western boundary of the State of Pensylvania. The Geographer shall designate the townships, or fractional parts of townships, by numbers, progressively from South to North, always beginning each range with No. 1, and the ranges shall be distinguished by their progressive numbers to the westward the first range extending from the Ohio to the Lake Erie being marked No. 1. The Geographer shall personally attend to the running of the first East and West line, and shall take the latitude of the extremes of the first North and South line, and of the mouths of the principal rivers. The lines shall be measured with a chain, shall be plainly marked by chaps on the trees, and exactly described on a plat, whereon shall be noted by the Surveyor at their proper distances, all mines, salt springs, salt licks, and mill seats that shall come to his knowledge, and all water courses, mountains and other remarkable and permanent things over or near which such lines shall pass and also the quality of the land. The plats of the townships respectively shall be marked by subdivisions into lots one mile square, or 640 acres, in the same direction as the external lines and numbered from 1 to 36, always beginning the succeeding range of the lots with the number next to that with which the preceding one concluded. And where, from the causes before mentioned, only a fractional part of a township shall be surveyed the lot protracted thereon shall bear the same numbers as if the township had been entire. And the Surveyors in running the external lines of the townships shall, at the interval of every mile, mark corners for the lots which are adjacent, always designating the same in a different manner from those of the townships. The Geographer and Surveyors are to pay the utmost attention to the variation of the magnetic needle, and are to run and note all lines by the true meridian."

But a year from that time this part of the law was repealed for the reason that it delayed the survey.

There were to be, under this law, seven ranges of townships laid off next to Pennsylvania and sections reserved for use of the continental army, and every section 16 for school purposes.

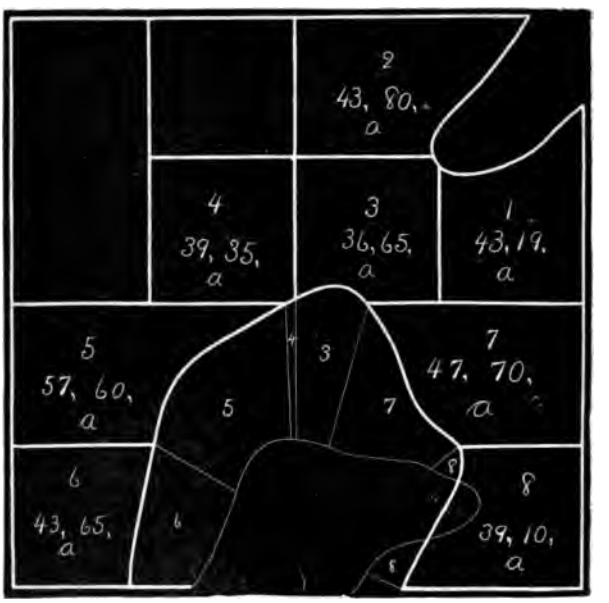
The theory and practice of no pre-existing government could give them a precedent, and this simple and efficient system shows a good knowledge of engineering, and a shrewd planning for the future. It shows that the illustrous statesmen of that age were fully aroused to the inestimable value, present and prospective, of the national territory, and the importance of early opening the way for settlement and the transfer of title to any portion, even the smallest fraction of the immense public domain.

In the first attempts to apply this system, some theories succumbed to practical difficulties, and in the State of Ohio was the first field of strife between order and disorder.

It was so covered with the traces of each that now the map of that state may be compared to the irregular patches of the "off" end of a Kaleidascope, which we may examine at some other time.

QUESTIONS OF PRACTICE.

The following questions of practice submitted to Mr. Leavenworth were reported and answered by that gentleman:



McBRIDES, October 17, 1886.

MR. I. H. LEAVENWORTH: -

Dear Sir: - I am called upon to survey the lands shown on the annexed plat.

The government maps show the lake as the heavy lines represent it, while the light line represents the real outline of the lake as described to me.

Now the question is: Shall these lines be projected to the lake? By so doing Lot 5 will receive a valuable lot of timber.

Should the North and South ¼ line be projected to the lake?

Should No. 5 receive all of the W ½ of the S. W. ¼?

I sent the same question to the General Land Office, Washington, D. C. The reply is emphatic. "Your lines should close on the Government Meandered line."

I think this a good question for the Convention.

All the Surveyors I have talked with say, "Project those lines to the lake."

F. A. PALMER.

ANSWER.—From the point where each line intersects the Government Meander line, deflect that line to a course that would strike the center of the lake and run to low water as per dotted lines, as lots 6, 5, 4, 3, 7 and 8 are each entitled to their share of the lake front. (See Cooley, proceedings of 1883, page 121.)

I. H. LEAVENWORTH.

The answer was not adopted by the convention as the question was understood to be likely to come before the courts for settlement.*

2nd. How shall the division line of the following description be run?

Commencing at the North ¼ post of Section 15, thence running West 100 rods, thence South 160 rods, thence East 100 rods, thence North 160 rods to the place of beginning, containing 100 acres according to the United States survey.

ANSWER.—Divide the quarter section by setting a post on the section line at the distance of 25 chains of government measure, west from the quarter post, and another on the East and West quarter line at a distance of 25 chains of government measure from the center of the Section, and run the line from one post to the other.

In other words, divide any difference that you may find between your measure and the measures returned in the field notes of the United States survey *pro rata* between the lots. Adopted.

MR. HODGMAN—I wish to call attention to the report of the Nebraska Association of Surveyors for 1884 and 1885, page 39, in which a member of that Society criticises the method adopted by this Association for restoring lost interior section corners, viz.: in a right line between nearest known corners to the North and South. I know we have never adopted or approved any such method, and I was going to write to the gentleman and call his attention to the injustice done us, when, on looking over the reports of 1862, I find that he is apparently justified in his criticism by the published answer to question No. 7. Let us be put right on the record.

MR. LEAVENWORTH—The mistake was made in not sufficiently amending the answer as originally given by me, so as to meet the views as expressed and intended to be adopted by the Society.

On Motion of Mr. Bailey it was voted that the first two sentences of the answer to question No. 7. Proceedings of 1862, should be stricken out as not in accordance with the views of this Association, as expressed at that time.

*See report of 1887.

SUBTERRANEOUS SURVEYING.

H. B. STURTEVANT, MINING ENGINEER, LAKE SUPERIOR IRON COMPANY, ISHPEMING, MICH.

Before proceeding with the subject at hand, it will not be out of place to briefly describe the geological nature of iron mines, and how mines are usually wrought; and explain how and why surveying and surveyors are made serviceable in mines.

No two iron mines resemble each other very strongly; for the reasons: 1st, the geological structure of the various mines is quite different; and 2nd, the respective managements of the different mines have peculiar features in their methods of working their mines.

The ore bodies sometimes exist as lenses, but usually as veins of from five feet to 80 feet wide. The veins are often folded into synclinals or anticlinals. The ore may be either hard and slaty, or soft and earthy. The two kinds seldom occurring associated with each other.

The shaft, the outlet to the mine, is sunk in or near the ore body, either vertically or with an inclination, to a depth of perhaps 600 or 700 feet, and levels, or floors are established at regular intervals of usually 40, 50 or 60 feet, vertically. The levels are extended in the shape of drifts, chambers or crosscuts, as far as desired.

The usual method of mining hard ore is by chambers, the full width of the vein, and as high as possible without endangering the floor of the level above, and in length from 20 to 60 feet. Pillars 20 or 25 feet in length are left between the chambers.

In the soft ore mines, however, the ore has but little tenacity, and will "run" unless worked in small chambers and supported by timbers.

The soft ore is therefore mined by driving a drift lengthwise of the deposit, and then at regular intervals, making crosscuts or chambers across the formation and parallel with each other. The chambers are made 8 or 10 feet square. The greatest possible care is required to successfully work a soft ore iron mine.

If the mine contained but one vein, and that narrow and very regular, very little surveying might be necessary, but usually the vein is folded, or there are two or more veins, and great irregularity exists between them, and also in the width and trend of any particular vein.

In such a mine, especially if the workings are at all extensive, it is impossible even for those most familiar, to go through circuitous drifts,

and from level to level, by candle light, and obtain even a vague idea of the relative location of the different parts. This statement will be appreciated by those who have been in an iron mine.

It must be apparent to all that any attempt to work a large mine without a definite plan followed precisely, would result in expensive mining, danger to the miners and damage to the mine.

To secure the execution of a plan for mining, the mining surveyor is an absolute necessity.

The mining surveyor is required to ascertain by survey the extent and outlines of all the underground workings, to represent the same by plans and cross-sections, and show the superposition of the different levels. The geological nature of the rock formations must also be designated. He must also represent by maps the relative location of the underground workings and the surface. From a study of these plans and cross-sections, the surveyor is enabled to ascertain where, probably, bodies of ore may be found in advance of the workings.

He may then be required to establish a course or direction to be followed by a drift or shaft to reach such ore bodies.

He may be required to direct a drift or winze, from one part of the mine to some other, to facilitate mining operations, or secure ventilation.

In accordance with the plan of mining, he is required to locate and direct chambers, such that they will be parallel and at uniform distances apart, and also that the pillars on the different levels will be in the same vertical planes, to secure stability to the mine.

He may be required to locate a proposed shaft on the surface, and direct both its course and dip so that it will meet an objective point underground.

Then he may be required to direct the underground workings to the line of the proposed shaft, and after reaching which, to direct a raise to meet the party sinking, on the same right line; an exceedingly delicate operation.

Those are some of the duties of a mining engineer.

The land surveyor, or railroad surveyor, can, to a large extent, check his work as he proceeds. But in nearly all of the work of the mine surveyor he can have no absolute proof of its accuracy until the drifts, shafts or chambers which he has directed, are completed.

If the work thus directed, on completion, proves the surveyor to have been correct, all right, but if incorrect, he has to face an embarrassing combination of circumstances. The extra expense of rectifying the error may be hundreds and thousands of dollars. The time so lost may be worth much more to the Mining Company, and besides his error cannot be obliterated, but stands forever as conspicuous as a sign board which might read "unreliable surveying done here."

The instruments used in mining surveying are the transit and the tape line.

The transit instrument should be as light and compact as is consistent with accuracy, for it must often be carried and used where a large, heavy instrument wiuld be in danger of injury, and endanger the person using or carrying it. The instrument used by the writer is a Gurley Light Mountain Transit, 8 inch telescope of power of 20 diamters, and weighs, mounted 22 or 23 pounds.

The instrument, aside from the usual fixtures, should be furnished as follows: Extension tripod, quick leveling tripod head, shifting center leveling plates, an auxiliary telescope for sighting on very great inclinations; this is detached, and is best fitted above the main telescope; horizontal limb and verhier solid silver and reading to minutes, white celluloid reflectors over verniers; platinum cross-wires; vertical limb, 180 degrees, movable on axis of telescope; bubble and clamp and tangent movement to telescope.

The needle, although accompanying the transit, is out of the way, and so there is no objection to its presence; but it ls so very unreliable that it is of no use in an iron mine.

The writer has not unclamped the needle on his instrument, to use it, for months.

Plummet lamps, and object glass reflectors, and diagonal prisms for the eye piece, are in the way and unnecessary.

The tape measure should be of steel ribbon 100 feet long and ¼ inch wide and divided to 100ths. A small 10 foot tape is also convenient and desirable, as is also an extra plumb-bob.

In this connection it might be well to mention that the mining surveyor must be thoroughly conversant with the use of the transit. He must also thoroughly understand geometry and trigonometry, for although in regular straight-forward surveying but a few principles and formulae are used, yet he frequently has occasion, when circumstances have compelled him to resort to irregular methods of surveying, to use a very general knowledge of these studies.

The methods to be discribed, although they may differ somewhat from other engineers, are those of the writer, and are found perfectly adequate to all requirements in iron mines, and are equally serviceable in any other kind of mine.

The method is essentially traverse surveying, with regular leveling.

A base line is established on surface; for convenience a portion of a section line, and the section corner or quarter corner taken as latitude 0.00 and departure 0.00 and elevation 0.00; or the elevations may be referred to the engine house floor, or the cellar of a shaft.

The survey is carried to the mine, triangulating where possible to check the work; down through a shaft to the underground workings, and extended on the different levels. The stations are made permanent both on surface and underground and concisely and definitely described in the field notes. If the mine has two shafts the survey should be taken down the second one, and the "circuit closed" wherever practicable.

And then in his office the surveyor calculates the latitude, departure and elevation of each station, and plats the survey accordingly. He also keeps a coomplete record of the same in connection with his field notes. And then, after a little calculation, the exact mathematical relation between any two stations is known; and on short notice the surveyor is able to go into the mine, "tie" on to his survey and establish the shortest course from any one point of the mine to any other, or to any point on surface.

This is the general scheme. Now as to details. The general scheme mnst not be lost sight of, but we as surveyors and engineers appreciate the importance of details in carrying out a scheme to secure *accuracy*

"Accuracy," the watchword of the C. E. "Accuracy," without which a survey is treacherous, malicious and deceptive.

To secure accuracy in details, *every element*, angular or rectilinear *is duplicated, and otherwise checked wherever practicable.*

Extreme thoroughness in mining surveying is urged for two reasons:

1st. The disadvantages under which the mining surveyor works, render liability to error very great.

These disadvantages are: Darknees, or candle light, next to darkness; water dripping over himself, transit, and field book; dirt, making it difficult to keep legible notes; short sights, often of only ten or fifteen feet; liability to displacement of stations; and also he cannot be sure at all times that his assistant follows his instructions in holding light or tape; he is often obliged to assume cramped and trying positions in taking sights; for instance up or down a shaft; where besides he is in danger of life and limb.

Our brothers, whose work is on surface, will please imagine themselves out on a pitch dark night, in a rain storm, trying to make a survey, and they will get a vague idea of some of the difficulties which beset the mine surveyor.

The second reason for urging thoroughness, is the great and unnecessary expense which an error in a mine survey invariably involves.

To duplicate each element of the survey and to check by closing circuits wherever practicable, is no reflection on the ability of the surveyor to make an accurate survey without these operations. It is merely an acknowledgement, in which every engineer of experience will agree, that even with the greatest pains-taking, mistakes are possible; the mistake might be either in reading the angle, or the measurement, or in recording the same. What surveyor can say that he has never transposed the figures of a reading in recording it?

Stations are located with great care that the next succeeding foresight will be desirable, and that it can be made permanent, and out of danger of disturbance by laborers.

A nail is driven into a tie of the train track, and to make the Station permanent, a horse shoe nail, previously prepared by having the head flattened, and a hole punched through it for suspending the plumb-bob is

driven into a timber vertically over the station. Stations are designated by numbers consecutively; but for convenience a set of numbers is adopted for each level separately. For instance on the 300 feet level, the stations would be numberd from 300 upwards, on the 340 feet level, from 340 upwards.

USE OF THE TRANSIT.

To take a sight on a station, an assistant holds his light close to, and behind the head of the nail, so that its outline is seen against the flame of the candle; and the cross-wires may be clearly seen when covering the light. To illuminate the wires in searching for a station, the surveyor holds his light in front, and to one side of the object glass, sighting at the same time.

We will suppose the surveyor is carried from station "one" to "two," and it is desired to continue it to station "three."

The instrument is set over 2; the back sight is taken to 1 with the telescope reversed, and the vernier plate clamped at the traversed course from 1 to 2; unclamp the vernier plate, bring the telescope to its normal position, i. e. with bubble under, and take the foresight to 3; the course from 2 to 3 will be given by the same vernier that was used in taking the back-sight. To check the work, the angle included between 1, 2 and 3 is taken, reading from 00 to the right; the lower clamp is then loosened, the vernier plate remaining clamped as read, and the telescope is again sighted to 1; the vernier plate is then loosened, and a sight is again taken to 3. The reading should give exactly the double of the first reading. If it does not, in the same way, the triple and quadruple of the first reading may be taken, and the included angle 1, 2, 3 definitely ascertained. To read the included angle to the right always, it may be necessary to read from 3 to 1 instead of 1 to 3. This included angle should be the same as that given by the traverse courses, i. e. the supplement of difference between the courses. If they do not agree the error is detected on the spot and corrected. But one vernier is used during the entire operation. The vertical angle to both foresight and backsight is taken; and the distance is measured from each to the axis of the telescope.

The height of the axis of the telescope above the station where set up is also measured.

These operations are repeated at each successive station, so that the horizontal distance between, and relative elevations of any two consecutive stations may be computed from two distinct sets of readings, each including a vertical angle, a distance, and the height of instrument; these should check each other.

This method is used on levels as well as in surveying down or up winzes or shafts, where sometimes the auxiliary telescope must be used; in which case the vertical angle must be reduced to the main telescope.

Some engineers prefer to determine elevations, where practicable, by horizontal leveling; instead of trusting to angular leveling; for the reason

that, as the vertical angles are often very small, a very slight error in the reading may give a considerable error in the vertical component of the measurement. The practice of horizontal leveling is commendable rather than otherwise, however, with care the angular leveling may be made perfectly reliable.

To carry a survey down a vertical shaft it is necessary to plumb down with two lines to a level below; an operation requiring great care and ingenuity. The pumb-bobs are suspended as far from each other as possible, and by fine binding wire; fine wire is preferred to a strong, because it is not effected by moisture or drafts of air, and is not so elastic.

The plumb-bobs should weigh at least a pound each; and to prevent vibration are lowered in pails of thin oil; signal oil is servicable; water is recommended by different authors, but it is not as good as oil, in shafts where water is dripping; as a drop of water or dirt falling onto the surface would produce a wave motion which might disturb the plumb line; oil will not be thus affected. The last course at the collar of the shaft may thus be carried down the shaft, hundreds of feet, and the survey continued underground.

To ascertain the outlines and extent of an underground chamber, the instrument is set over the most convenient station, and a B. S. taken; using the traverse course. The instrument is then sighted to the different corners and jogs around the walls of the chamber, and the traversed angle from 0 to 360 degrees to each is read and at the same time the measurement from each to the instrument is taken. The different points of the mine are thus successively outlined. This operation of outlining chambers may be done in connection with the main survey if desired. On reaching the office it is an easy matter with the protractor and scale to re-produce on paper, the outline survey of the mine.

The method of recording notes in the field book should be simple and explicit. Every angle or measurement should be recorded immediately after taken, trusting nothing to the memory. Every page of the field book should be headed by the date in full.

The field book of the writer is kept as follows:

340 FEET LEVEL, SOUTH VEIN, SEPTEMBER 3, 1885.

Stations	Included Angle.	Course.	Verti. Ang.	Dist.	H.I.	Descriptions of Stations, Etc.
346	141° 36′					
341-342	237° 12′	173° 12′	-3° 12′	80.65	4.20	342 in tie of track, and cap.
342:341			-2° 45′	80.63	4.18	
*341	154° 02′					
342-353	308° 01	147° 24′	-8° 02′	38.55	4.18	343 in end of tie at joint.

*The 342 is where the instrument is set up; 341 is the b. s. and 343 the f. s.

The complete record in the office contains besides:

Horizontal dist.	Vert. Dist.	Differ of Eleva	Eleva of F. S.	Co-Ordinates. Lat.	Co-Ordinates. Dep.	Lat.	Dep.	Remarks.
80.35	-4.51	+0.31	-345.92	-79.97	+ 9.33	-782.12	+786.18	
80.24	-3.85	+0.32	-345.93					
28.27	-3.99	+0.21	-345.71	-23.78	+15.30	-805.91	+801.48	

The whole is also platted.

In this manner the entire mine is surveyed; and the engineer has a mathematical network encompassing the mine; giving him at once the exact rectilinear relation which any one point in the mine bears to any other. By continuing the survey on the surface he is prepared to designate the mathematical relation between any point underground to any point on surface. For instance: A new shaft is desired from a given place on surface, to another geven place underground. The management are in a hurry for the shaft, and so desires one party of miners to commence on surface to sink, and another party to commence u nderground to raise; the two are at work toward each other till they meet.

Very well; the surveyor, presuming his survey is thoroughly made and tested, and records are complete, will, after a few hours spent at computing, establish a course and dip for each party to follow; and although the "dead ground" between them may be hundreds of feet, he believes that the parties following his directions will "hole," i. e. meet on the same right line, as firmly as he believes he knows the summation of 5 and 5, without designating that summation by figures.

Without this confidence he is not warranted in giving directions; and this confidence in the accuracy of his survey can be inspired only by the knowledge that the most thorough methods have been pursued—the double entry method of surveying.

H. B. STURTEVANT,
Mining Engineer, Lake Superior Iron Co.

Ishpeming, Mich., Jan. 15th, 1886.

SANITARY AND DRAINAGE ENGINEERING.

Your committee would respectfully report: That the following are the necessary conditions of healthy homes, viz.:

1. A dry site, free from malaria, with a light cheerful outlook.
2. Ventilation sufficient to carry off all respiratory contamination.
3. A system of immediate and complete sewage removal.
4. A due supply of water fit for use, with proper provision for removal of the waste.
5. Such construction of the foundation, walls and roof that perfect dryness is insured.

The first belongs to the owner's department aided by the engineer in draining the site if not dry, and the surrounding country if needed, to prevent the malaria. The second and fifth are turned over to the architect, leaving the third and fourth and part of the first as the peculiar province of the engineer.

We do not deem it our duty to recount the wonderful works of ancient or modern times for the supply of water, or for the removal of sewage, by cities.

It would be interesting to show how the death rate has been reduced by these means. What a wonderful change was wrought in Memphis, Tennessee, after it had suffered from yellow fever. Their need is unquestioned and their importance cannot be overstated.

While we have no improved plan to offer, we feel that we must urge their importance and call particular attention to the fact that the people are poisoned by their own excrement. Fifteen to twenty thousand people die in this country annually from this cause.

"It is to be desired that the people may be so educated as to stop this *shameful* cause of death and prevent this awful waste of human life."

The cities have given care, thought and money, to devise and execute systems which shall accomplish both these objects –furnish a supply of good water and prevent its contamination. But the villages and the country are not yet awakened to their danger.

The well and the privy vault alternate from lot to lot. When a well fails to supply water for the family use another is dug by its side a few feet deeper, and after the old one is used as a receptacle for slops from the house and any other filth, for which no place is provided, which furnishes the best possible conditions for infiltration to the wells.

Is the wonder that so many die or that so few are poisoned? How can the people be taught?

The complete record in the office contains besides:

Horizontal dist.	Vert. Dist.	Differ of Eleva	Eleva of F. S.	Co-Ordinates. Lat.	Co-Ordinates. Dep.	Lat.	Dep.	Remarks.
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Is the wonder that so many die or that so few are poisoned? How can the people be taught?

Our State Board of Health publish the facts, which at much pains and cost are gathered, but who reads them?

The people *pay* for *collecting*, *printing*, and *distributing* the *very knowledge* for lack of which they are *dying*, and then they *will not read* and *use it.* Our people are destroyed for lack of wisdom.

A cheap practical plan or system of water supply and sewage removal adapted to the wants and *means* of villages is greatly needed and it will be found when the people earnestly desire and seek it.

And we shall be glad to aid in spreading a knowledge of it.

'Tis said the field of engineering science is widening year by year as new problems arise.

The Premier of Great Britain said from his place in the Commons: "That intemperance destroys more lives than war, famine, and pestilence." If true the most profitable drain possible (and most necessary to to the public health) is one that will remove all the products of the breweries and distilleries without giving them a chance to poison mankind. There seems to be a lamentable want of knowledge in regard to this kind of a drain. It seems to be an unsolved problem. No treatise seems to describe it. Great financial results could be expected, and many lives would be saved. It would be a sanitary measure of the first water.

Land drainage has two great objects, viz.: Health and Profit.

All our drain laws depend on the former for their force or reason, and the latter for their execution.

And as it seldom happens that one individual owns the whole of a wet tract of land together with the outlet necessary for the drainage, the progress of drainage depends very much on having a practicable law, clear and explicit, with its interpretation well fixed by courts, so that a good lawyer need have little fear of having proceedings quashed, or the collection of the tax for the construction of the drain perpetually enjoined.

Would it not be better for the Legislature of this State to model its drain laws after those of some state where such laws have been in operation for a term of years, and so get the benefit of their experience?

We should have *no law*, or *one under which* it shall *not be* possible to drain the land owners' pocket more than it does his land, and which shall not defraud the men who do the work on the drain by allowing work to be done for which no one can be compelled to pay.

It needs to make provision for deepening the bed of quite large streams in certain low portions of the State. Also for draining the marshes along the lakes and rivers by a system of dykes and ditches. When Niagara Falls wear back into Lake Erie we shall have more use still for such work, and shall have new problems to contend with.

The drainage interests of the State are in their infancy; and it is a great pity that the work cannot be thoroughly done. In the present state of public opinion we can do little more than remove the surface

water. But when men begin to use this land we find they soon learn that removing surface water is not draining, and soon the work must be all done over at great loss to the people. It is much cheaper to do a thing well the first time than to go over the work three or four times to secure a good job.

All of which is respectfully submitted.

CHAS. E. HOLLISTER,
E. F. GUILD,
DORR K. SKEELS,
Committee on Sanitary and Drainage Engineering.

REPORT OF COMMITTEE ON TECHNICAL EDUCATION.

WHEREAS, It is our opinion from what we have been able to see and hear while at this session of the Society, at the University, that the present system of education is tending toward the introduction and development of practieal knowledge, especially in the branches most nearly related to the scope of this society,

Therefore resolved, that we will use our influence and give our hearty support, both as individuals and as a society, to adopt, extend and maintain such a system of popular education in all schools in any way supported by the State that shall give the most to the masses seeking an education.

That we consider it especially important for the State to liberally aid the departments of Civil and Mechanical Engineering and Physical Science; that they in turn, who are skilled both in *mind* and *hand* may aid the State in the development of its great Agricultural and Industrial resources.

That we urge our legislators to make all needful appropriations to aid such Polytechnic departments as are already provided in our State institutions and to increase the facilities for experimental instruction therein.

GEO. E. STEELE,
H. D, BARTHOLOMEW,
A. J. TEED,
Committee.

REPORT OF COMMITTEE ON INSTRUMENTS.

Mr. Chairman and Gentlemen of the Michigan Engineering Society:

Your committee to whom was referred the exhibit of instruments, take pleasure in reporting that this exhibition has proved a very interesting and profitable feature of the meeting, there having been a very large and valuable collection of instruments exhibited by manufacturers

among which many new improvements are to be noticed, and many new and valuable instruments and improvements are exhibited by members of the Society.

Mr. Wm. F. Gurley, representing W. & L. E. Gurley, of Troy, N. Y. exhibited:

1 Surveyor's transit and level complete.

1 Surveyor's transit, single vernier.

1 Engineer's plain transit.

1 Light mountain transit with extension tripods, level and vertical arc; having also the verniers so arranged that they can be read without the position of the observer being changed.

1 Mountain transit with solar attachment and having a level attached to the outer end of the telescope axis so that the latitude can be easily regained after using the telescope out of latitude.

1 Vernier compass, 6 inch needle.

2 Vernier pocket compasses, 3½ and 4½ inch needles.

1 Pocket railroad compass.

1 20 inch engineer's level.

1 Architect's level.

1 Farm drainage level with compass attached.

1 Locke's hand level.

1 Architects leveling rod.

1 Pocket level for plumbing a rod.

One noticeable feature of two transits exhibited by Gurley and Beckman, is the clamp nicely adapted for the horizontal limb which clamps the spindle independent of the limb thereby obviating any tendency to spring the limb or vernier plates.

Mr. F. W. Gardam, representing W. Gardam & Sons, of New York, exhibited:

1 Complete engineers transit, very finely graduated.

1 Light mining transit, having a new style of extension tripods and side telescope for vertical sights.

1 Engineers level, with rapid leveling attachment.

1 Detached level and vertical arc for plain transit, the invention of T. M. Jackson, of Clarksburg, West Virginia.

2 Section liners of improved make.

1 Improved geological compass.

1 Translucent target for mining or tunneling work that can be seen at a long distance by holding a light behind.

Mr. L. Beckman, of Toledo, Ohio, exhibited:

1 Engineer's transit.

1 Engineer's level.

1 Hodgman tape.

Mr. Beckman's instruments reccommend themselves by their simple and concise form of construction. He makes a noticeable improvement

in the bearings of "wyes" by means of placing therein agates ground to the curve of the bearing collars of the telescope.

Mr. T. L. Johnson, representing Queen & Co., of Philadelphia, exhibited a very large line of drawing instruments, the superior quality and fine workmanship of which were apparent to all who examined them, but owing to a lack of time your committee are unable to mention them in detail, but feel justified in saying that this firm can undoubtedly furnish anything that is to be desired in their line. We noted among other improvements a decided improvement in the drawing pen and in dividers, the use of the Alteneder joint on which the patent has expired.

Mr. C. S. Woodard exhibited a self-reading level rod which by means of a tape attrched, can be extended to any desirable height.

Mr. B. F. LaRue, exhibited Mr. H. F. Bean's patent leveling and cross-section rod and cross section tape, and President Davis exhibited an improved and modified construction of the same rod. This rod is so constructed as to do mechanically all of the tedious mathematical operations in mining levels and doing cross section work, and your committee very earnestly recommend it to the attention and consideration of the members of this Society.

The model of a machine for laying tile was exhibited by Mr. L. S. Alter, delegate from the Indiana Society, which seems to be well worthy of attention.

President Davis exhibited a very excellent reel for a steel tape. This is decidedly the best thing we have seen of the kind.

Mr. G. E. Steele exhibited a United States standard steel rod 72 inches in length.

In conclusion, we wish to respectfully recommend that the thanks of this Society be extended to those geutlemen who have so kindly brought their instruments here for our examination.

Very respectfuly,

BENJ. F. LARUE,
B. F. WELLES,
GEO. MARSH.
Committee.

Mr. Steele said he had donated to the University his standard steel rod on certain conditions, among which was this: That the members of the Engineering Society, and others, were to have their measuring instruments tested, by the payment only of the necessary charges for transportation on the same.

Mr. T. L. Johnson, representing James W. Queen & Co., of 924 Chestnut street, Philadelphia, who was present with quite a number of the smaller instruments for observation, and a full line of drafting instruments and material, read a paper eulogizing the firm and their work.

During the past 30 years they have sold of profile paper alone, almost sufficient to stretch a girdle 22 inches wide twice around the globe.

The firm have just commenced the manufacture of Transits and Wye levels. They claim a superiority for the graduations on the arcs and circles, as the lines are not brought down to the edge of the metal, so that they can remain clear and distinct longer. They have adopted all the modern improvements for securing safety to the exposed points and protecting them from dust or other foreign matter. The point to which they would especially call the attention of the profession is the perfection of their lenses. They make all they use and grind each set for that particular instrument, so that the perfect line of collimation will be retained a much greater length of time.

Frederick W. Gardam, representing W. Gardam & Sons, of New York, read a paper discussing the old question of holding the graduations of a transit permanent in adjustment.

Theoretically, any angle read by one vernier on the horizontal circle should be exactly repeated by that opposite.

Practically, this is one of the most difficult problems the manufacturer has to solve.

First. The conditions under which any instrument is used are scarcely ever twice the same.

Second. Personal aberration exerts a strong effect. Rarely will two persons read the same instrument alike under precisely the same conditions of light, temperature, etc.

To prove these statements, subject an instrument to sudden changes of temperature, jars and concussions, such as a transit receives in daily work, and almost invariably it will be found that the errors in reading are quite perceptible, thus showing that the adjustments have been disturbed by the unequal expansion and contraction of the horizontal circle and the circle carrying the vernier.

"To avoid this trouble we have constructed the horizontal circle and verniers in such a manner as to leave an annular recess between the adjacent parts, and by pouring in a plastic material (which expands slightly in setting), the perfect concentricity between the edge of the horizontal circle and the center of the instrument is retained."

The writer hoped that some standard of excellence might be adopted limiting the error in graduations and setting up a test for the magnifying and defining power of a telescope.

The paper closed with a description of a new translucent target especially useful in mines and tunnels or above ground in dark, cloudy weather.

RESOLUTIONS ON THE DEATH OF JAMES SANDERSON.

WHEREAS, The Michigan Engineering Society has been called, during the past year, to mourn the loss from our membership, by death, of James Sanderson, of Detroit, late one of its vice-presidents.

Resolved, That we gladly bear testimony to his fidelity and ability as an engineer, and shall cherish his memory as a most worthy member of our Society.

H. C. THOMPSON,
CHAS. E. GREENE,
ALBERT EATON,
Committee.

Mr. James Sanderson, one of the first vice-presidents of this Association, and one of our most promising members passed away from our midst during the past year, at the age of 38.

He was born at Marquette, Wis., in 1857, and graduated from the Michigan University in 1878 with the degree of C. E.

He was first employed on the United States Lake Survey, and then became connected with the Iron Bridge Company of Detroit. He was rapidly developing a character and reputation for honesty, energy and perseverance, when he was called hence, to be mourned for by friends and associates.

REPORT OF COMMITTEE ON NOMINATIONS.

ANN ARBOR, January 28, 1886.

To the Members of the Michigan Engineering Society:

GENTLEMEN: Your committee to whom was referred the nomination of officers for the ensuing year, beg leave to report the names of the present officers for your support as the officers for the coming year, and would suggest that provision be made for an additional secretary, to be known as Recording Secretary, and would report the name of H. D. Bartholomew as such secretary.

And your committee would further suggest that in future, provision be made for the election of officers by paper ballots, without referring to a nominating committee.

All of which is respectfully submitted.

JOHN J. WATKINS,
F. HODGMAN,
BURTON KENT,
Committee.

The report was accepted and officers elected as follows:

PRESIDENT—PROF. J. B. DAVIS.
VICE-PRESIDENT—GEO. E. STEELE.
SECRETARY AND TREASURER—R. C. CARPENTER.
RECORDING SECRETARY—H. D. BARTHOLOMEW.

PROCEEDINGS—1887.

Michigan Engineering Society.

OFFICERS FOR 1887.

PRESIDENT, GEO. E. STEELE, Traverse City.

VICE-PRESIDENT, E. F. GUILD, East Saginaw.

SECRETARY AND TREASURER, F. HODGMAN, Climax.

ASSISTANT " " GEO. S. PIERSON, Kalamazoo.

EXECUTIVE COMMITTEE.

M. E. COOLEY, Ann Arbor, H. A. COLLAR, Grand Rapids,
A. L. DREW, Three Oaks.
and the President and Secretary Ex-Officio.

STANDING COMMITTEES.

Manual—

F. HODGMAN, Climax, C. F. R. BELLOWS, Ypsilanti.

Land Surveying—

I. H. LEAVENWORTH, East Saginaw, A. J. TEED, Cadillac, CHAS. E. HOLLISTER, Laingsburg.

City Surveying—

GEO. S. PIERSON, Kalamazoo, JOHN J. GRANVILLE, East Saginaw, WM. APPLETON, Lansing.

Highway Surveying—

HENRY CAUKIN, Greenville, DONALD A. MCLEOD, Moline, JOHN M. SANBORN, Gaylord.

Railroad and Bridge Engineering—

ARTHUR L. REED, Port Huron, ROBERT E. WILLIAMS, Jackson, STEWART G. JOHNSON, Grand Rapids.

Mechanical Engineering—

JESSE SMITH, Detroit, ROLLA C. CARPENTER, Lansing, CLARENCE G. TAYLOR, Ann Arbor.

Hydraulic and Mining Engineering—

CHAS. D. LAWTON, Lawton, FRANK P. MILLS, Chicago, H. B. STURTEVANT, Ishpeming.

Sanitary and Drainage Engineering--

A. C. SEKELL, Grand Rapids, SETH N. BEDEN, Pine Run, M. H. BAILEY, Diamondale.

Rivers, Harbors and Lighthouses—

J. A. MITCHELL, Grand Rapids, JOSEPH RIPLEY, Sault Ste. Marie, B. H. MUEHLE, Detroit.

Highways and Highway Bridge Construction—

WM. B. SEARS, East Saginaw, WM. P. INNES, Grand Rapids, BURTON KENT, Adrian.

State Boundary—

GEO. A. MARKS, Hillsdale, J. K. YOCUM, Chelsea.

ANNUAL CONVENTION, 1887.

The convention met in the Superior Court room in Grand Rapids, on Jan. 25. The President, Secretary, and a majority of the Executive Committee were absent for various reasons, and the attendance was somewhat below the usual number. In spite of all the discouragements, the meeting proved a very interesting and profitable one. Many kindly courtesies were received from the citizens of Grand Rapids, especially from Capt. W. L. Coffinberry, who donated some rare and valuable instruments to the Society. Col. Samuel Wells who extended the hospitalities of the Soldiers' Home, the Grand Rapids and Indiana Railroad Co., who transported the members to the plaster beds in a special car, and Mr. Hovey of the Grand Rapids Plaster Company, who conducted them through the quarries and mills of that company. For these and other courtesies, the convention gave a suitable expression of their appreciation and thanks.

ABSTRACT OF SECRETARY'S REPORT.

TUESDAY, JANUARY 25, 1887, 2 P. M.

The convention was called to order, Vice-President Geo. E. Steele in the chair.

The Secretary's chair being vacant, M. E. Cooley was appointed secretary pro tem, H. A. Collar, assistant.

J. J. Watkins and A. J. Teed were appointed pro tem, to fill the places of absent members of the Executive Committee.

REPORT OF COMMITTEE ON HYDRAULICS AND MINING.

In answer to the call for reports of committees, C. D. Lawton, of the Committee on Hydraulics and Mining, submitted the following report on

THE TAMARACK MINE.

Gentlemen:

The Tamarack mine is now a reality; it is no longer a matter of conjecture, a thing of the future, a problematical shaft, driving downward vertically a half-mile into the earth, but it is an accomplished fact.

The Tamarack is now a mine, already producing copper on a large scale, and rapidly stepping to the front, soon to be second only to its great neighbor in the list--the youngest and most vigorous of our mines.

In every particular this great enterprise has been a success; from its conception, from the time the first blow was struck, there has been no deviation, no change and no delay; the work has progressed steadily to its conclusion. All the statements and estimates that were primarily set forth by the promoters of the scheme, are fully verified in the result. The lode was found at the estimated depth, and within the time and cost allotted for the work. And, now that it is probed, after the long traverse through seemingly impenetrable rock, the deposit is proving to be all that the most sanguine could reasonably hope for. Altogether the Tamarack shaft is one of the boldest and most successful mining enterprises on record, and reflects immeasurable credit upon those who have planned and executed the work.

The company was organized January 1, 1882, and the work of sinking the shaft was begun in February thereafter, and on June 20, 1885, (three and a-half years from the date of commencement) the lode was struck. It is an example of the most rapid sinking, in hard rock, that has anywhere been done.

The lowest monthly rate of sinking in 1882 was 42 feet, and the highest, 59.8 feet; the average per month for the year was 41.4 feet. In 1883 the lowest monthly rate of progress was 44 feet; highest, 67 feet; average for the year, 59.7 feet. In 1884 the lowest monthly rate of progress was 58 feet; highest, 70 feet; average 63.4 feet. In 1885 the lowest monthly rate of progress was 60 feet; highest, 68 feet; average, 64 feet. Total depth from surface to Calumet lode, 2,270 feet. The varying rate of progress is due, it is said, to the character of the rock which was encountered. Thirty-two different beds of rock were met with in the

first 1,200 feet, dipping northwesterly about 39 degrees with the horizon. Among these beds was the Allonez conglomerate, which was but two feet in thickness at the point where it was cut, and carried but little copper. An amygdaloid bed that was intercepted, proved better. Three tons of copper were obtained in forcing through it, and other similar beds were cut, showing more or less favorable indications.

From a depth of 350 feet down very little water settled in the bottom of the shaft; the percolation above, however, is sufficient to keep the timbers thoroughly saturated, and to cause some dripping down the shaft--a good security against fire. The timbers are 10x14 in size, and there is not the least particle of evidence of any excess of pressure.

The cost of sinking, all expenses included, was $61 per foot. Rand's Little Giant drills were used in sinking the first 1,400 feet, and then two of Rand's "Sluggers" were introduced; the latter were found very suitable in extremely hard ground. The Little Giant is admirably well adapted to the work of penetrating rock of ordinary texture. Eighteen to twenty-four holes were drilled in each twenty-four hours' time, varying from five to seven feet. They worked six days per week.

Giant powder was the explosive used in the earlier part of the work, later, that made by the Hancock Chemical Company was used, the per cent. of nitro-glycerine varying from forty to fifty, according to the hardness of the rock.

The total expenditures to January 1, 1886, have been, in round numbers, $274,000; the assessments amounted to $330,000. The expenditures in December were $14,060, and against this 125 tons of copper were taken out.

They pay now for sinking $28 per foot; the cross-cuts from the shaft to the lode cost $8 per foot, average, and driving in the conglomerate costs $12 to $15 per foot. The cost of stoping varies from $10 to $14 per cubic fathom.

Objection is raised to the great depth of the shaft before the lode is reached; but this seeming obstacle is speedily dissipated into thin air when we consider the perfection of the mechanical appliances for overcoming it. One can go to the bottom of the Tamarack shaft or rise to the surface from its greatest depth in merely a moment of time, and with nearly as much quietness and safety as he may ride in a hotel elevator. The rate of hoisting in the copper mines has usually been not in excess of 400 feet per minute; the Calumet & Hecla with its new machinery hoists 800 to 1,000 feet in this time, but its skips run on rails inclined 39 degrees to the horizon. The Tamarack in its vertical cage shaft, operated with the minimum friction, will as easily hoist 1,600 feet to 2,000 feet per minute the same load, so that they are, in point of time, no deeper, practically, at 2,000 feet, than others limited to the old rate of speed are at 500. The shaft is now (February, 1886) 2,360 feet deep; the plumb lines which Mr. Klepetko, the mining engineer, has dropped to

the bottom, show it to be perfectly straight and true. It is substantially made, 19x7 feet inside the timbers, divided into three compartments, and every provision is made for safety.

The ropes are new, made of the best steel wire, and possess a strength far in excess of the strain to which they are subjected.

Each cage is provided on either side with automatic, self-acting safety dogs that instantly clutch the guy posts and stop the cage if by breakage or other causes the rope slackens.

Two compartments will be used for hoisting, the third one for carrying the men and for timber, etc.

This latter cage will have an entirely independent plant of machinery, designed especially for it. The compartment is not yet in operation, but is rapidly approaching completion. The rockhouse is joined to the shafthouse, the screen dump being but 25 feet from the mouth of the shaft. The capacity of the rockhouse is equal to 1,000 tons per day. It is one of the best on the lake, is covered with iron to render it fireproof, and is of ample size, well arranged and provided with every facility to meet all the future work of the shaft. The present shafthouse is of wood, but it will soon be displaced by one wholly of iron—iron frame and iron covering. The enginehouse is 112 feet southwest from the shaft, it is sheeted with iron inside and such other precautions taken as to eliminate as far as possible the danger from fire. The two hoisting engines are each 30x27, the winding drum is coned at the ends, the central portion being cylindrical, end diameters 14 feet, central diameter 18 feet. The engineer can tell at any moment at what point the cage is in the shaft.

It is possible that the maximum product the company will hoist in this single shaft will be 600 ton per day, but the shaft has undoubtedly a capacity of 1,000 tons of rock per day.

By using the two compartments, double-decked cages in each, 1,000 tons can be hoisted per day and cared for in the rockhouse. This amount would employ a force of about 350 men. At present the company has ,all told, 122 men, 66 drill men, working 11 drills, 5 landers, 20 trammers, 12 timbermen, 5 men in the enginehouse, and 3 men and a boy in the rockhouse, the average underground wages being $2 per day.

They are now hoisting an average of 200 tons of rock per day. The December product was 125 tons of mineral; January, 174 tons and February, 200 tons, [The product for March was 220 tons.—Ed.] obtained from a total of 12,000 tons of rock, thus showing a yield of 8 1-6 per cent of mineral, which yields 76 per cent of copper. In January they stamped 4,310 tons of rock, obtaining 174 tons of mineral, equal to 133 of copper, or to a percentage of 3 1-12 per cent ingot. The rock is treated in the Osceola mill at Torch Lake, seven miles from the mine, and reached by the Hancock & Calumet railroad, a line that has been built and equipped from Calumet to Hancock via the Osceola and Tamarack mines, with a branch to Lake Linden, and a switch to the stamp mill, during the past year by the Tamarack and Osceola companies.

Of course, the first thing in order is a stamp mill, and one will be built in the near future adjacent to the Osceola mill. It is expected that the earnings of the mine will provide the necessary funds. The mine produced in February, 150 tons of refined copper worth 11 cents per pound, the cost is not much above $3 per ton of rock now, and the rock yields 16½ pounds of refined copper to the ton, so that the cost of the copper is not much above 6 cents per pound, a good margin of profit to accumulate the money to build a mill and for other necessary expenses.

The mine is looking well, the lode averages about 12 feet wide and as far as opened is all good ground, that is, all the vein carries copper, not in equal amount, however, some of it is very rich, but the rich rock and the poor are everywhere, in all parts of the lode. If a light is thrown upon a smooth, vertical section of the deposit, it shows the rich and poor rock nicely. The dark, barren points are strongly contrasted with the segregations of light colored rock richly impregnated with mineral. A small amount of rock, 5 per cent, is rejected; this comes in part from the hanging, but also, mainly, from a deposit of sandstone that occurs in the vein south of the shaft. It is of variable width, but at no place takes more than two feet of the vein, sometimes against the hanging and again leaving a few feet of rich conglomerate between it and the hanging; in places it is simply a thin seam and disappears entirely. So far they have no rich shoots of copper as are found in the Calumet & Hecla, to bring up the average percentage, a difference, that is more than compensated for by the comparative diminished cost of production in the Tamarack.

There is nothing non-essential to be seen about the mine, the machinery, etc., is simply what is required for the work. The whole plant and arrangements are snug and compact and economically operated. I deem it altogether probable that the Tamarack will produce copper more cheaply than any mine in the world. The mine itself is airy and comfortable, there is no pleasanter mine to be in, nor one which can be more easily entered or ascended from. It may be remembered that the shaft is in the corner of the company's property which afforded the shortest distance to the lode—in the s. e. cor. of the w½ s. w. ¼ sec. 14, t. 56, r 33. The whole estate comprises 1280 acres—all in sections 10, 11, 14, and 15, town and range above given. The shaft is 260 feet from the corner, horizontally measured, at right-angles to the strike of the formation; and this length of vein passing through the shaft from the east line to the south line is 570 feet, that is the triangular point of the lode embraced between the line and having its apex at the corner and lying above the shaft, is 570 feet base by 335 altitude. The dip of the lode—39 degrees—gives nearly 100 feet of length of vein for each 60 feet of perpendicular, i. e., of vertical depth.

The ground above the shaft is opened in three levels, the upper being 104 feet, horizontally, from the corner and the length of the lode between the lines is 224 feet. The second level is 65 feet, vertically, below No. 1, and has a length of lode between the lines of 400 feet. The third level is

57 feet, vertically below the second, and may be opened a length of 2,570 feet. At the time of my visit, they had sunk the winze and driven the cross-cut for the fourth level; the winze was through as rich conglomerate as any I saw in the mine. Of course the mine is not largely opened, as only five months have elapsed since the opening work began.

The levels are connected by winzes in the lode, and there are heavy pillars to protect the shaft where it passes through the conglomerate. Otherwise than this the vein will be all taken out, leaving in addition about 400 feet of the deposit standing along the lines of the property.

The shaft will be continued down vertically and the lode reached by cross-cuts from the shaft, driven at suitable intervals, probably at every second level. Of course, these cross-cuts lengthen as the shaft deepens, but the matter of driving now is so quickly done and costs but little, comparatively, that it is of minor importance to what it would have been formerly. Aside from the mere question of cost, the vertical shaft possesses advantages that are very great. These are: the concentration of work, due to the rapidity of hoisting; the safety and permanency of the shaft, due to the fact that it is all the way in solid rock, in the foot-wall, where nothing can ever disturb it; also the fact that but little timbering will be necessary, the copper deposit will all be taken out, saving the cost of timber and of pillars. The obviating of the necessity of leaving pillars is a valuable consideration, when we remember that the rock is worth $3.50 per ton standing in the mine, and the further fact of the great cost of timbering that would have to be met if the system of mining adopted should require that the mine should be kept intact.

One cage comes up as the other descends, but one drum being necessary—in fact, there is the least machinery for the amount of mining done, of any in the district.

It is planned to sink No. 2 shaft; the location for it has been made and preliminary steps taken to begin the work of sinking. [This second shaft has since been commenced and is now down to the rock—ED.] The shaft will be 731 feet north of No. 1, and will intersect the lode at 325 feet below the point at which No. 1 intersects it. The north and south line connecting Nos. 1 and 2.—parallel with the east line of the property—forms the hypothenuse of a right-angle triangle, of which No. 2 is at the angle of the base, No. 1 at the apex, and the perpendicular and the base, are respectively 416 feet, and 600 feet in length, measured horizontally.

The former distance is the length of the cross-cut from No. 1 at right angles to the formation; the base is the line of the strike of the lode at the point where the shaft will intersect it. The distance from No. 1 at right-angles to this line of the strike, and measured on the plane of the vein, will be 538 feet; that is No. 2, which will be the same distance from the east line of the property as No. 1, will be 731 feet further north from the line, and also 676 feet from the southeast corner, measuring at right-angles to the formation. This location of the new shaft was determined with a view of making a proper distribution of the ground to be stoped

and so dividing it as to make the most economical working of the two shafts. It will be 6x18, inside the timbers, and be divided into three compartments, same as No. 1.

These two shafts have a capacity of 2,000 tons of rock per day, equal to a daily product of 60 tons of ingot copper, which I venture to predict will be produced, as I stated before, at a lower cost than any equally large amount of copper has ever been heretofore mined. But while restricted to the Osceola mill, it is not probable that a greater average monthly product than 350 tons will be reached.

The capital stock of the company is divided into 40,000 shares having a par value of $25 each—but which were worth in April last $33—and at the present time are quoted at $90, at about which figure they have been held since October.

The mine is officered by the following gentlemen:

President—Joseph W. Clark.

Secretary and Treasurer—A. S. Bigelow.

Agent—John Daniell.

Mining Captain—John B. Quick.

Other committes not being ready to report more time was given.

ADDRESS OF WELCOME.

At the opening of the morning session Capt. W. L. Coffinberry was introduced by Mr. H. A. Collar, and welcomed the Society to the hospitalities of the city in the following words:

Mr. President and Gentlemen of the Society:

Many years ago, I had the honor of being one of a number of gentlemen who associated themselves together and organized a society of Engineers and Surveyors, very similar in its style to your society, and having the same objects that you have. It is not necessary to go into the details of the causes why it failed to accomplish the grand object of its organization; for it died a premature death. I see that a number of its members are members of your association. I never regretted so much, anything in which I had no personal interest, as the death of that association. I allude to this, so that you may see why I take such a live interest in your association and desire its complete success, and it is gladly, that on behalf of the citizens of Grand Rapids, I welcome you to this city.

There is at this time manifest in our country, what I am very glad to see, a disposition to bestow a great amount of honor upon the early pioneers and the first settlers, because they braved the difficulty, toil, danger and privation of pioneer life. They are the men who took their families and moved into the then unbroken wilderness, and made unto themselves homes; who had no road along which to travel, but those cut

by themselves; and no guide through the woods to the lands they had selected, other than the marks on trees, made by the surveyors of the public domain. I would not pluck one feather from the coronet of the noble pioneer, and yet I will ask who made those marks upon the trees of the forest, by which that pioneer found his way to that land? Who *was* it, that, in order to make those marks, waded through streams, slept on the ground; who was weary and fatigued with his exertions; who often found himself with but scanty provisions in his larder, and only those of the most simple kind, that might be easily prepared in the woods with scanty kitchen furniture that he could carry; who was continually tormented by day and by night, by the malicious musquito with his poisonous bill and villainous song; whose sleeping hours were almost nightly shortened by the screech of the owl, and the howl of the wolf. Who were those fellows? what sort of men were they, that could leave family and friends, household and home, early in the spring and go into the woods and remain until late in the autumn without hope of seeing a human face in that time or even a book or a newspaper? I can tell you. They were scientific men; civil engineers and surveyors. It was they, who, in the interests of civilization marked the locations and boundaries of these lands. They meandered our lakes and our rivers. They fixed the boundaries of our territories and our states, and they certainly deserve the credit due their meritorious work and services in the cause of civilization. The honor is due to their profession, and should be promptly demanded and received.

I have been requested to state some of the reminiscences of my early professional life as connected in some measure with such pioneer life, and I have consented to do so. It will necessarily involve some statement of my early life, and the preparation that I underwent for that position.

My father, immediately after the war of 1812, became the first settler, and the pioneer, of the township in which he for a long time made his home. As soon as the settlers followed him in, he made an effort to have the blessings of an educational system established among them and for that end, presented a piece of land suitable for that purpose off from the corner of his farm for a school-house site. It was built there. I remember well that I went there for two quarters, as they called it, that is three months in the winter for two winters in succession. It was then discovered that I could not see as well as my brothers and other school children did; it alarmed my parents, they believed that I was becoming blind and called in the doctor, he diagnosed my case, and prescribed, what? First, a dose of calomel; second, a blister upon the back of my neck; third, that my ears should be pierced and green strings put in to make them sore; fourth, a string of beads made from the root of burdock to be hung around my neck; fifth, a snuff box filled with snuff, to be used constantly; sixth, a pair of large convex glasses put on my eyes to be

worn all the while; and lastly, that I should be taken out of school, and not allowed to read a word at home.

I continued to work upon the farm until between 18 and 19 years old and then I begged of them to let me go and learn a trade. There was no prospect before me but to work—work on the farm—I preferred a trade to it.

With his consent, I engaged with a millwright and carpenter to learn that trade, working with him until I was 21 years of age. During the time I was learning my trade, I went to school for three months, one in each year. I became a journeyman and worked at it until I was 22 years old, here and there. When 22 years old, I was working for myself in Fairfield county, Ohio. The engineers were then about laying out the old Ohio Canal in that section of country. I was boarding at the same hotel, at which the engineer in charge was boarding. His axman became sick, so he requested me to take his place for the day, and use the axe, and make and drive stakes. I did so. That afternoon when we were returning to the hotel, a man who was building a stone culvert on that section came and met us and requested the engineer to make him a pattern of the ring-stone of the arch. The reply was that he had no time to do it, but could direct him so that he could do it; so he laid down on a plank, the contractor's long straight-edge, which he used in cutting the stone; he stuck it to the plank, by means of boring a gimlet through it, then he says: "Measure seven feet from that as a center, to the periphery of the arch, there make a gimlet hole in the straight-edge, put in a scratch awl and strike the arc of a circle, and a foot further out, make another gimlet hole and strike another arc of a circle from the same center, those arcs being inside and outside of the circle, and then for the head joints of the segment; strike" he said, "a line by the side of your straight-edge," which was about 4 inches wide, "from one end of the stone, and the other side of the straight-edge, for the other end of the stone, and that will give you the lines of your pattern." I was standing by; I asked the engineer if he wanted the head joints of this stone to fit and be on the line of the radius? "Why certainly, I do." Then I said, you have not instructed him rightly. He stepped back, took off his hat, and with much humility made a bow. I was much agitated, and then he spoke loudly and sharply, and said "Mr. Coffinberry, if you know better how to tell this gentleman than I do, I wish you would tell him." I begged his pardon, saying I did not intend any offense, but he made the same reply, so I did then explain that he had drawn his head lines by the line of his straight-edge but not on the radius, and that those lines would run two inches each side of the center instead of running to the center of the circle. It was a singular incident, a boy of 22 attempting to instruct an old experienced engineer, but when I explained it, he took of his hat again, saying, "I beg your pardon, Mr. Coffinbery, you old mechanics are the fellows for engineers." His rodman who had been with him some two years, was standing by and should have seen it, but

he had'nt said a word. We arrived at the hotel, that ended my first experience with a civil engineer in the field. The next day he again asked me if I could go out, I said yes. He said, "Mr. Downs, the rodman, is not much of an engineer and we have no compass in the office and I must stay in the office to make some drawings. Mr. Downs knows where the lockpit is to be located, and will go with yon. The dimensions of the lock are in the book, but it should be parallel with the center line and extend out from it, for the workmen to go to work. I have no compass, but you old mechanics know how to do all these things." So from that day forward he put me in charge of the work whenever he could not be present. This continued about four months, I acted as principal assistant. I then became sick with billious fever; for two months he kept the place open, but I did not recover in time to again take it. That closed my first engineering job. So you see how, and in what manner I came to learn and take up the profession of a civil engineer.

After my recovery, I resumed my work of building mills, barns, and houses, continuing it until about 31 years old, then marrying; after that, continuing my trade four years more.

In the winter of 1835, the citizens of Richland county, Ohio, wanted some engineering done and obtained from Detroit, an engineer to come to Mansfield to do it. He had lost one hand, but was capable of doing considerable work in that line. He was informed that I had some experience in that line, and sent for me ; so I was engaged to assist him, and spending the greater part of the winter of '35 and 36 with him making preliminary surveys and leveling in that vicinity along the streams. In the spring of 1836, Gen. Curtiss, Major General of volunteers in the rebellion, under authority of the State Board of Public Works, raised an engineer corps in Ohio, I joined it and spent most of the summer of 1836 in running preliminary lines for railroads in that state. During the winter of 1836 and 7, I spent my time in drawing our plats and maps of the previous summer's work. In April, 1837, we went onto the Muskingum improvement which was the making slack-water navigation on that river. It was there, that the now Hon. John Sherman came and worked for me as my rodman and for two years boarded in my family. We worked at that into 1840, then the state became alarmed about their great growing debt they were making for internal improvements, and discharged us in the fall of 1840.

Then I went back to Mansfield where I had been raised and learned watch and clock repairing, paying $60 for instructions, and a year and a half's time. Then moved from there to Centreville, in this state, and engaged in that business, remaining two years. In 1846, I came to Grand Rapids and went into the same business and continued it until 1850, when Grand Rapids became a city, and I was elected city engineer, which I then held two years. Then I had a contract from the Surveyor General of the Northwest to act as deputy United States Surveyor, and re-survey all the government land in Missaukee county, which was then an

unbroken wilderness. This re-survey was actually original surveying. Range and town lines had been run by former surveyors, and my work was to subdivide those townships into sections. Most of the work there had been done in camp and not in the field. There were no lines or corners to be found inside of the range and township lines.

I spoke from experience when I spoke of the part the deputy surveyor, as all under the Surveyor General were called, had in preparing the way for the pioneer.

I shall not soon forget some of the trials we had in surveying the lands in that county, even though I become an old man, as I may, for I am now 80 years old.

On my trip to Missaukee, three two horse teams carried our camp equipage as far as the site of Big Rapids, for at that time not a stick of timber had been cut in that now flourishing city. The land belonged to the government, the lumbermen had, however, made a kind of road along which to haul in hay and feed for men and horses. On the site of Big Rapids, I had a big pine tree cut down and made into a canoe, large enough to take in a flour barrel crosswise. Our goods were loaded into that canoe, and we started up the Muskegon for our destination above the mouth of Clam river, there we unloaded and carried a load to Clam lake and then returned for another load. While we were gone for that load, a fire ran into our goods, burning our books, papers, tent, clothing, compass and everything that was necessary to do our business. There was no help for it but to go back and purchase a new outfit.

This delayed us; we arrived on the ground the second time and built a depot in which to keep our goods and provisions safe, away from the bears and the wolves.

Then, as we were almost ready for field work, my son, a young man who was with us became suddenly very dangerously sick, we did for him all we could, in a camp in the woods; it became evident that his chances of surviving there were slight, and he could be of no service on the survey for a long time, if he lived, we started with him, carrying him on our improvised stretcher, made of small poles and cedar bark. Four men carried him to Muskegon river, four miles away, through the woods, and laid him on the bed that we made in our canoe, and then paddled nown the river for home. Up to this time we had done nothing towards surveying the lands. We sailed down to the mouth of the river, where now Muskegon city is, found there a sail-boat which took us aboard to Grand Haven, where we took passage for home on a steamboat; stayed but one night at home, and then started on my return to meet my men at the forks of the Muskegon, now called Croton.

October came. I had to leave my work unfinished, and return the next season and finish it.

Little then, did any of us anticipate the rapid settlement of the northern half of this lower peninsula which has taken place.

While I was out working in the woods one day that fall, it was near night, the rain was falling fast, our camp was three miles away, I was making field notes in my book, of the bearings, and description of the land, as required by my instructions, when a man who was holding his coat over my field book to protect it from the rain and enable me to enter them, said: "Mr. Coffinberry, I wouldn't take so much pains to write out the minutes of this d——d swampy, miserable land, you and I will both be dead and in Heaven before anybody will be here to look up our tracks." The sequel to Dennis Hinkson's remarks is that it was delivered in the township where Lake City is, a flourishing village, the county seat of an organized county containing court house, saw mill and grist mill, and is connected by railroad with Cadillac, having communication by two daily trains. Dennis has passed to the other side, and I hope a better life, and I remain here, an old man of 80 years of age, able yet to read and write without the aid of glasses. At this time we had no idea that men were on our tracks taking notes of our work and entering the best lots of pine. We soon learned they were in there in this way. On quitting work that fall, and returning to our depot of provisions, I found that my satchel had been opened and a letter put into it, sealed, and directed to me, reading:

My Dear Sir:—Having had public business in this vicinity and getting nearly out of provisions, I got into your store-house and helped myself, and if I did not leave money enough to pay for what I took out, write to me at," giving his full address, "and say how much more you want and I will send it to you when I get home," and then signed his name.

I am seeking by these incidents to place before you, as well as I can, such a description of the way we had to manage in those days, as shall vindicate my assertion as to the indebetedness of the pioneers to that great pioneer, the Deputy United States Surveyor.

When I was on my way down the Muskegon in the boat with my sick boy, we saw a little ways below us on the bank, a bear standing upright, like a man, picking berries. We had one man in the canoe who had a good rifle. He was a stuttering, excitable person, he could not talk under excitement without having first used a cuss word, and under these circumstances would say, you—you—you—you, four or five times in quick succession, and then the oath would come, and then he would speak his words very rapidly. I told Dennis to lie down in the bow of the canoe, for bruin had not seen us; we floated noiselessly until within good shooting distance, then he fired. Bruin dropped into the river and sank to the bottom in a few feet of water. When we got there we could see him rolling on the bottom. He was brought to the surface by a stick being twisted in his long hair: I took hold of the top of his head, towing him behind us until we came to a low bank where we pulled him ashore. Dennis was fingering around his throat to show the point he aimed at, what hunters call, the sticking point, when bruin gave his last gasp. Dennis made a wonderful jump, yelling you—you—you—you—ending

with an oath, adding, "Mr. Coffinbery, I can step out of the way of a bear as quick as any other man you ever saw." You see that such a life was not entirely devoid of a comical side.

I think I have just cause for pride in another piece of work that I did in the spring of 1859, the surveying of a swamp land road from the northwest corner of Kent county, to Northport, in Leelenaw county, a distance of 157¼ miles. I was engaged to do it in the spring of 1859 and at once proceeded to. For 22 miles of our way we had a sort of road upon which could be carried our camp equipage and our baggage, so we at first traveled light, then we entered the wilderness with our knapsacks strapped on our backs and our working tools in our hands and had packmen engaged in bringing in our provisions. Our only guide was a state map, with my trusty compass. Its needle guided us safely and truly. I did not have the benefit of the government lines to aid us. We made very good speed considering the circumstances under which we had to work, without the aid of the government lines, but when we reached those and had the benefit of them, we made more rapid progress. When we struck the line between 11 and 12 west, we followed it for many miles measuring and noting all circumstances and matters that could be of importance to the Commissioner of the State Land Office.

The survey was begun April 20th, and finished May 20th, being just one month.

On this survey, we occasionally struck a very blind trail made by the half-breed Indians who were carrying the mail between Traverse City and Grand Rapids in winter time, for in summertime they were carried on the lake boats.

From time to time we wrote short accounts of the progress of the survey, the nature of the country, and other matters that seemed to be of public interest which we gave to the mail carrier for we met him several times. Those letters were eagerly read by people for the descriptions of the country they contained. Mr. Kingsbury and Mr. Palmer, two of the three commissioners were along with us during our whole trip, the other was A. B. Watson, now a resident of this city.

In the Spring of 1860, I had a contract for cutting forty miles of that same road next north from Newaygo. When I completed that I had nothing to do and went back to Grand Rapids. Soon after the rebellion broke out, a regiment of engineers and mechanics were being raised by General Innes, himself also a civil engineer; I saw that I could be of special use to the government, and my patriotism prompting me, although I was then 62 years old, I raised a company of 100 men and joined that regiment, and we did, I believe, excellent service, which helped along materially in a small way the end.

It looks as if some of my work in this city must live to let later generations know that such an one lived and took part in the pioneer work of the city, for I have laid out and platted 75 additions to the city of Grand Rapids. In addition to that, I have platted and laid out plats

in, I think, thirty other towns of Michigan. Among the plats of record in the office of the register of deeds in Kent county, there will be found about thirty made by Coffinbery, Skeels & Collar, of which I had the special supervision and in the making of which I was ably assisted by my talented associates.

I don't consider my life work yet done. With my hearing, my sight, and my locomotive powers well preserved, I am yet able to do something towards my part of life. I yet lead an active life in looking after those of the unfortunate and destitute of the county that have occasion to call upon the superintendents of the poor of this county for assistance. I give my personal attention to their wants, needs, and representations.

When old age does overtake me, gentlemen, I hope to be able to say, in my small way, I have cheerfully done what I could towards the progress of the world.

Which was responded to by Geo. E. Steele, as follows, in the

VICE PRESIDENT'S ADDRESS.

Mr. President:

Permit me in behalf of the Society to say, in response to our respected fellow member and through him to the citizens of this thriving city of Grand Rapids, we are glad of their hospitable welcome.

We come not with the tumult of warring hosts, to bring their implements of strife within your gates.

We come not with the fair promises the politician has, to leave behind our discords, envies, hates.

Nor like some traveling men who grumble at a nice beef-steak, but smile on pretty waiter girls.

We are not a Salvation Army troupe to vex the City Council grave, and ring out discordant dinner bells.

Not that we disapprove of saving men, but do not want our meetings on the streets.

Nor are we exactly like a County Fair, with lots of cabbage heads, and crazy quilts, and beets.

But come to march our cavalcade around the ring, we think that every one would tally underneath the string.

No mountebank with us can play his tricks, nor plug hat gentry selling walking sticks.

Our show is somewhat novel, and as it costs you nothing, for ought we know it may be worth its cost.

It is true the canvas that we raise and stakes we pound are more than all the shows above the ground,

The elephants we have are such as P. T. Barnum tried to get to spout the water up Mount Ararat.

Our clowns are of the cubic sort, when once knocked down their height remains as great.
The lions and the tigers too are all on wheels,
And perfectly obey their keeper Skeels.
The trapeze men in our employ can leap a cannon before the cook can put his coffee on.
The tight rope dancers balance all,
With Wagner cars before the falls.
And when you want a hole drilled through a Rocky Mountain wall just call around. The boys will have it done to-morrow noon so that LaRue can ship a load of kangaroo by next day freight.
Our Treadwell says he has a track from here to Saginaw and back.
No doubt when this is advertised, small hippodromes will look surprised.
And when you talk of water mains we will not doff our Coats to any one.
We stake the ground for laborers and have respect for honest toil.
We bury deep the solid base, and spring our arch for centuries.
The tools we use are those of Peace, the works we build, the Nation's Pride.
Come then, and with us take a part,
Put on your bestist Hat and Come!
If in the course of argument our Doctors disagree, complacently look on.
They may do nothing worse than give seme extract of cube root.
If anything is said about a bridge whose spinal chord gave way, just mark how sure the one who drew the plan will skip a thousand miles away.
If hieroglyphics on the board appear like starless night, remember, when this world is burned they'll be as clear as light.

And now, fellow members, and gentlemen, it was with much reluctance that we assumed the responsibility of this annual address, in place of our worthy President, well knowing that the one who tries to fill his place, must be a technical Sampson, able to parry the most sturdy blow which either theoretical or practical students can give. His mandate is our only excuse. The excuse is about equal to the exigency. Perhaps if our hearers, with proper commisseration will do as much as to catch the foxes, we can light the firebrands, setting them free to do effective warfare for the cause in which we are engaged. It is this cause—the searching after facts in engineering pursuits—which gives keen enjoyment to these annual re-unions, and makes their return with their pleasant hand shakings and agreeable exercises only too far off on the calendar—only too distant when but a week intervenes. It is with some degree of satisfaction that we review the work already accomplished by this society, started, as it was, but a few years ago by those who realized that the union of their hands was the betterment of them all. We now possess

some valuable reports, and have the reports of other similar societies; and those who are here united are much more efficient than they could be without the association of other active "yoke-fellows." The early peradventure has formalized into a public good and into that measure of success and strength, which promises still more for the future.

But a society cannot live on the air it has breathed any more than can the individual member.

It must be re-vivified by new forces, oxygenated by new ideas, energized by every one within its membership. Indeed, it need not stop with its membership, but may set to work those outside of its organization.

Please to bear with us then, while we encompass the field and mark its salient points.

A very good polaris to take our bearings from is this:

a.—EVERY ONE MUST WORK.

It should be expected that each member of this Society would make a note of some matter of his study and experience, and at any time most convenient, or at the annual meeting place it with the society. This plan could not fail to add greatly to the value of our yearly compilations. Our "barns" would have to be built larger very soon. It is safe to say that not one can pursue his calling, a twelve-month without having that practical experience, not laid down in the books nor taught in the schools, which others ought to know. An active mind can gather where the thorns are thick. Then, too, we know the engineer wherever he may be, is favored, as almost no other class is, with opportunities for original discoveries or observations. By these means our resources have been greatly developed; the locations of oils, brines, minerals, local attractions, the distribution of valuable woods, the fauna and flora of our country. Also in the problems he has been called upon to solve, the settlement of disputes, the behavior of certain woods and members of various structures, the preservation of earth-work, and difficult things which he has overcome in water ways, engines and machines. The programme must be made to give our new members an opportunity. The diffident must be drawn out, the indifferent urged; the drones (if any) carried a safe distance from the hive and dropped. (This is an apicultural allusion which is not original with the vice-President.)

As in intimate relation to what has just been said, and a corrollary of it, another point is made.

b.—CONTINUE THE QUESTIONS.

We do not mean simply as to the manner of running lines, but in the whole scope of every department of this Society. We should make these so prominent a feature that members will urge their answers, and long to get the general opinion of the Society, as a little Toodles longs for Santa Claus. A question being considered will often recall in older members a proper answer from their own experience. These all should

be worked up by an able member, or by several members in committee before the annual meeting, as much as possible.

c.—IMPROVE OUR INSTRUMENTS.

While the work of the civil and mechanical engineer is always founded on demonstrable formulæ, unfortunately the fine edge is usually taken off when he comes to carry out his theories instrumentally. To reduce this error to a minimum is the constant effort of the skilled instrument maker. But here again the instrument maker must say farewell to his theories, for the reason that he cannot always demonstrate them in his own workshop. He is quite ready to know what the practical engineer thinks of them. Hence our meetings have been promotive of improvements through our pleasant criticism, and we have been laid under great obligations to these gentlemen for their willingness to adopt any suggestions of value, and for the fine exhibition of instruments at our meetings. We were greatly pleased and instructed by a recent visit to one of the large manufactories of engineer's instruments, and found that quality not quantity was stamped, as we may say, upon every piece of wood and of metal, upon every machine and every operative or skilled workman. A mere glance at the intelligent faces seen through such an establishment is enough to show the kind of work we may expect it will turn out. But an engineer should not be a machine and simply take and use whatever may be put into his hands. He should have bad forms of instruments improved; and we can still do much in that direction.

d.—REPORT IMPROVED MACHINES AND CONSTRUCTIONS.

As growing out of what has just been said of instruments, this Society should have a committee whose constant effort should be to note new machines and forms of construction most noteworthy and valuable to its members; and condense those observations in an annual report to the Society. This work need not interfere in the least with the standing committees already existing.

e.—A COMMITTEE ON DECISIONS.

The Society would be greatly benefitted by having some person or committee, who should prepare a brief digest of any decision of our State, or United States Courts, or official rulings which pertain to the surveying or engineering profession. If you will pardon the innovation—a kind of "Court Committee." We need not assume to do this as the legal profession would do it, but purely for our better information and guidance. The fund of decisions and rulings thus made available to our members would soon be considerable.

f.—FIELD NOTES.

The method of taking field notes, both in subdivisions of United States surveys and in engineering work should be fully considered and

discussed, so that more uniform methods may be practiced, and the best forms adopted. A great saving of time in calculations would no doubt result.

g.—INCORPORATION.

It seems advisable to consider now whether or not this Society should become incorporated by the laws of the State. It would be taking a step towards its more permanent organization. It would add to its standing and stability, and if we should be favored with any donations or succeed in making any collections, their proper care and custody would be provided for. There are not corresponding objections in our opinion. But we only ask for inquiry at the present time.

h.—DUTY TO THE STUDENT.

The members of this Society are in one sense all students. It is a question of degrees and minutes after all. But, as we never can see ourselves by looking in the glass, so we can never know what others think of us unless we give them opportunity to judge. We should encourage the attendance at these meetings of students of engineering, whether they be members of the Society or not, in the hope that they will become such, and that we may assist them as well. There are very many questions here discussed which, if the older ones had had opportunity to hear in their student days, would have been prized. And who has not greatly desired, when far removed from any such opportunity, the counsel of those more experienced? or, can any one say truthfully that he has attended these meetings without stimulus to study, or returned to his home without benefit? All the safeguards reasonable and proper should be set up to protect our membership; but, on the other hand, cynical exclusiveness should be avoided.

i.—HISTORICAL AND BIOGRAPHICAL.

We cannot omit a mention of these points, although the plan so far laid out is considerable. As an active and useful society it seems to us that we have only commenced our proper work. The collation of biographical and historical data, and the collection of maps, instruments, relics and specimens pertaining to early surveys and engineering work, is certainly very important. How eagerly we now listen to the personal experiences, the plans and discoveries of those who in the past have done so much for our own and for other states! To the early work of Rittenhouse, Hutchins, Burt, Houghton and many others we refer with both curiosity and pride. With what reverent regard do we handle any of the instruments, never so rude, which have been in the hands of our father surveyors! They, and the men who took part with them, have gone, or are fast passing away; and there lingers around the hearthstones of their homes the faint embers of their camps or the dusty corners of their shops, those recollections never set to words, which if once swept out can never be brought back.

The unwritten cadence of their lives is not set to rhyme. There, in the distant prairie, the wild forest, or craggy mountain range—far removed and perhaps surrounded by wily foes—were carried on with many privations, those labors which mark a State, and make the nation great. There were encountered the problems which have in their after solution given us many advantages, covered our broad western states and territories with a network of lines, an orderly succession of related mountains, and established such a subdivision of the public domain as was never before equaled or attempted in the world.

Measured by its simplicity it is as nothing, but measured by its economy it is priceless.

During the last half century have been made the most astonishing advances in all that pertains to engineering.

Cities, great now and swelling with their teeming peoples, have been laid out on the open plains, and built up with all the known appliances for modern comfort. Wide rivers have been tunneled, and bridges have been swung mid-air, to exceed anything ever before attempted.

Great enterprises and inventions have followed each other in such quick succession that, now, if a miracle should be performed, the world would no longer stand agog, but would squint up the other eye and say, "I told you so."

This wonderful development will, in the next half century, be followed by the most praiseworthy efforts to perpetuate the memory of those who have taken part in it. Every historic and biographical incicent relating to the laying out of our western towns, the projection of the great railroad lines, and all the varied improvements in this and our sister states will be sought for and preserved. It is thus that history is formed, and the common things of to-day are the prized gems of the to-morrow. This society can do very much in searching through the nooks and crannies and gathering what they have not sown.

CONGRATULATIONS.

We congratulate the members on the improved prospects for the coming year, and after a season of inactivity there seems to have come one full of great plans for engineering improvement in all parts of our State.

Rejoicing in the busy prospects ahead let us not overlook the work we have to do as members of the Michigan Engineering Society, and however we are engaged let us prepare early for our next annual gathering, bringing with us, each, some sheaves of ripened thought and golden experience.

The thanks of the Society were tendered Mr. Coffinberry, the Mayor and Citizens of Grand Rapids, for the pleasant welcome received, and to the Vice-President for his instructive address.

On recommendation of the Vice-President, Mr. Charles Sturgeon, of Columbus, Ohio, was made an honorary member of the Society and invited to participate in the proceedings.

The Committee on amendments to the Constitution made majority and minority reports, which were laid on the table until Wednesday.

Mr. Hodgman read a paper on "Deflections of lines in Township Boundaries," being the substance of a paper prepared by request of the Illinois Society of Surveyors and Engineers for that Society, setting forth the reasons for the ruling adopted by the Michigan Engineering Society, not to deflect a township or range line to pass through closing corners which were planted outside of those lines. These reasons are briefly that:

1st. The law requires that "the boundary lines actually run and marked in the United States surveys shall be established as the proper boundary lines of the sections or subdivisions *for which they were intended*" and hence, that to deflect the lines away from where they were actually run and marked for the Township boundary, to pass through corners where no line ever was run and marked for that purpose, would be contrary to law.

2nd. That it is contrary to the instructions and the rulings of the General Land Office.

3rd. That in case the closing corners should be off the Township boundary on either side, but in such position that the closing line passes over, or would pass over the standard corner if it were extended far enough, it would be impossible to so deflect the boundary as to pass through both corners, thus showing the fallacy of the principle.

Invitations were received from Capt. Coffinberry, to visit his residence and inspect his cabinet of curiosities, also from the Grand Rapids Plaster Company, to visit their quarries on Thursday.

These invitations were accepted with thanks by the Society.

Wednesday Morning, January 26.

Invitations were received from Capt. Coffinberry to visit certain street improvements, and from Col. S. Wells, to visit the Soldiers' Home, which were accepted for Thursday.

Mr. W. R. Coats then read a paper on River Crossings for Water Mains, illustrated by photographs and drawings.

Laying Water Pipe across Grand River at Grand Rapids.

RIVER CROSSINGS FOR WATER MAINS.

To the Michigan Engineering Society:

How best to cross rivers and water courses, with water mains, is one of the most interesting and important questions involved in water works construction.

During the last ten years there has been an almost marvelous advance and improvement in nearly all branches of water works construction, and we are, I think, fully as far advanced to-day, in the practical mastery of the science of hydraulics, as we are in any other field of scientific work; yet in the branch of hydraulic work, chosen for the subject of this paper, the general practice is very far below what it ought to be.

Very nearly all the cities of our country are so situated, that in the construction of water works, rivers or other water courses, have to be crossed with water mains, and it is of the first importance that these river mains should be put down in such manner as to be safe from injury from any and all dangers to which they may be exposed; and yet, not one in ten of the river crossings so far made throughout the country have been made in a scientific manner, or in such manner as to secure the highest degree of efficiency, and permanence of service. There are four different ways for the accomplishment of this kind of work, and we will consider them in the inverse order of their excellence.

First is the quite common mode of carrying our water mains across streams upon highway bridges; this method is the simplest, easiest, most bungling, and least defensible of all. Where we carry our mains across streams upon bridges, it is usually necessary to box them in and pack them in some material that will protect them against frost; to accomplish this effectually, requires so much space as to seriously interfere with the legitimate traffic over the bridge, besides sadly marring the good looks of the bridge; again, we cannot repair or re-build the bridge without disturbing or removing the water main.

It is very rarely the case that the conditions are such as to enable us to carry a water main acoss a stream upon a bridge, in such manner as to secure a satisfactory result; only one such instance having come to my knowledge, a description of which I will give further along.

The next in order of excellence is the laying of our main upon the bed of the stream without any trenching or covering, simply allowing the pipe to conform to the shape of the stream bed.

Laying pipe in this manner is usually done from flats, occasional flexible joints being provided to relieve the strain; such work is bungling and unsatisfactory to say the least.

Thirdly—and vastly better—is the mode requiring a carefully prepared trench in the bed of the stream. Then putting the entire river section of main together, upon a properly constructed false work, directly over the trench, lower the entire line of main to place *simulta-*

neously, and in such manner as not to injure any of the joints. Then cover the main by filling the trench, and remove the false work.

The fourth, and probably the best mode, where the conditions will permit, is to construct a permanent tunnel under the stream, and lay our main in the tunnel in such manner as to render it at all times accessible; but this mode is so expensive that it is impossible to adopt it in the great majority of cases. I do not think it worth while to take up the time of the convention with any details concerning it.

The only fully successful and satisfactory crossing that I have ever been able to make where bridges have been used, was made in Pawtucket, Rhode Island, in the construction of the water works at that place in 1877-8. We there found it necessary to carry a twenty inch force main across the Blackstone river, at a point below the Pawtucket falls of that river. The river at this point was spanned with a double arch, granite bridge and it was directed to make use of this bridge to carry the force main. The bridge was an exceedingly favorable one for this purpose, it being constructed of very heavy granite blocks, with the sides carried up solid four feet above the road bed, and the road bed heavily ballasted with sand and gravel, and paved in the ordinary way, with granite blocks. In putting this main across, a trench was first cut in the road bed of the bridge; this trench was four feet wide and four feet deep, ten inches in depth of fine coal cinders were placed in the bottom of the trench, and upon this the main was laid, after which the trench was filled with cinders to a few inches above the top of the pipe, and the sand and gravel ballast, and the granite pavement replaced.

After the work was completed, there remained not the slightest outward evidence that a large water main had been laid across the bridge, or that the bridge had been in any way tampered with. Preparing the trench across this bridge was a very arduous work, all the rock having to be cut out by hand, as we could not use explosives without endangering the bridge structure. In making this trench, it was found necessary to cut through within nine inches of the under fall of the arches. When the conditions are so favorable as in this case, there is no objection to making such crossings upon a bridge, but under ordinary circumstances I do not think there is any necessity, or excuse for doing so. In cases where the water in the stream is of sufficient depth, we can secure protection from frost by simply laying our main upon the bed of the stream without any trenching or covering, but in most cases, there are other dangers than frost to provide for. Hence, I shall discuss this branch of the subject, and confine myself to—if I may be permitted the expression—a discussion of *under-bed* stream crossings.

In crossing navigable streams our mains are exposed in greater or less degree, to disturbance by the anchors of vessels, unless imbedded and covered to sufficient depth to be beyond their reach. In cases where streams are used for log running and rafting, it is dangerous to have our mains exposed above the bed of the stream, as in such cases they are

liable to disturbance and displacement by the log jams which such streams are subject to. Again all our northern streams are subject to heavy accumulations of ice during the winter months, and when this ice breaks up and moves out with the spring floods, frequent ice gorges form and at such points as these engorgements occur, the erosive force of the engorgement mass, acting upon the bed of the stream, is sometimes enormous, and woe to our luckless water mains, if exposed to its action.

There are cases when the danger from these last named causes is so slight, that if we have water of sufficient depth to insure protection against frost, there is no very serious objection to laying our main upon the bed of the stream, without any trenching or covering, but it is better and more workmanlike in all cases, to thoroughly sink and cover our main, below the bed of the stream. The chief reason why this course has not been more generally followed, may be found, I think, in the difficulties, real and imaginary, with which such work is usually surrounded, and the limited *practical* knowledge available. It is, in most cases, easy enough to satisfy ourselves *theoretically*, how a difficult engineering work should be performed, but when we come to undertake the *practical* execution of the work we often encounter difficulties for which our theories have made no provision; in such cases we do not always possess the requisite courage to grapple with and master the difficulties, and the result is, we often change our base and adopt some make shift compromise, resulting in a work of no credit to ourselves or our profession, and of very little benefit to any body else. It is not, in my judgment, very often—if ever—the case, that we are called upon to perform a work so difficult of accomplishment as to justify or excuse these make shifts. We are often led to think otherwise, because of wrong and visionary theories. We *theorize* too much, we *practice* too little. Very many of us can execute a very fine piece of work, in picture, upon paper, but when brought face to face with the difficulties to be encountered in the execution of the *real* work, we often find that our theories do not fit, and becoming bewildered and lost in a wilderness of difficulties not foreseen, and provided for, we grope about in the darkness, until we finally stumble and fall beneath an avalanche of false theoretical rubbish. Do not understand me as making light of, or underrating *theoretical* knowledge. I only wish to impress this; *theoretical* knowledge is of but little value unless properly tempered with *practical* knowledge. There is, I think, a tendency with most engineers, to surround a seemingly difficult work with many imaginary obstacles, thus *handicapping* themselves in the outset; this has been true of my own experience, and nothing has been so effective in curing me of this fault, as the fact that in my early experience it fortunately fell to my lot to be placed, upon several occasions, in positions where it was imperatively necessary that *seemingly* very difficult work must be executed with very limited means, so limited in fact, that, but for the absolute necessity of *immediate* action, I could neither have found the faith, nor the courage, to even attempt anything;

but being compelled to do something, I would grapple with the situation and make the best possible use of the means at hand; and the result has almost invariably been a surprise to me, in showing how very much more could be accomplished than I had believed possible until stern necessity compelled me to act. So often have I met with this experience that I have come to the firm conclusion that there is no necessary work in our worldly work, however seemingly difficult, where means do not exist within our reach, adequate for its successful accomplishment, and when we have discovered the best means, we are surprised at their simplicity, and amazed that we could have remained blind to them so long. In my early experience in water works construction, the crossing of streams with water mains, appeared to me as a very difficult work; but a short experience taught me that nearly all the difficulties I had taken for granted, as standing in the way, only existed in my imagination, and for the most part they rapidly disappeared. I well remember the first time in my experience when I found it necessary to cross a stream with a water main; the stream was not very large, neither was the water main, but I did not then know how to proceed properly. I opened the pipe trench on both sides of the stream, procured a sufficient quantity of flange pipe to reach across, put it together in the trench upon one side; thoroughly bolted the joints, and then drew it through, and across the stream, and connected the stream section with the street line upon each side. I thought at that time that I had done fairly well, though I was by no means satisfied.

My next advance step in this kind of work was in crossing a river 450 feet in width; the water in the stream was 6 feet in depth—at ordinary stage—and the bed of the river was of sand and gravel, and almost a dead level entirely across. The current was so slight that it was not deemed necessary to imbed the pipe at all, but simply to lay it upon the bed of the river. The pipe was of cast iron and put together with lead joints. I chose a cold day in the winter for the work, when the ice was sufficiently strong to bear the weight of the pipe. The pipe was distributed and put together on the ice directly over the position it was to occupy in the bottom of the stream. When all was in readiness the ice was cut on the up stream side, one foot from the pipe and parallel with it, entirely across the river, and at intervals the ice was cut in the same manner on the down stream side of the pipe, so that when the ice gave way it would permit the entire line of pipe to sink instantaneously. I had some misgivings as to the result, but everything worked admirably, and the entire line of pipe went to place in the bottom of the river without the impairment of a single joint.

My next step in advance, consisted in the construction of a temporary bridge entirely across the stream on the line of the proposed main, and with long handled shovels and hoes, prepared a trench in the bed of the stream, after which the pipe would be put together upon this tempo-

rary bridge, and the entire line lowered to place *simultaneously*; the trench refilled, and the bridge, or false work removed.

I put a water main across the DesMoines river, at Des Moines, Iowa, in this way in 1883. The river at the point of crossing, being 600 feet in width.

I have not been able to improve upon this plan, except that I now use a dredging machine of peculiar construction for preparing the trench in the bed of the river.

The most successful and satisfactory river crossing of my own experience was accomplished in August and September last, in laying a 16 inch water main across Grand river, at Grand Rapids, Michigan. A description of this work has been chosen as the subject of this paper, not only for the intrinsic interest and importance of the work from a professional point of view, but also because it has been deemed especially appropriate that a description of this work should be given before the eighth annual meeting of our State Engineering Society, as the meeting is to be held in the city where the work was performed.

Many years ago, when water works construction was first undertaken at Grand Rapids, the Board of Public Works contemplated putting a main across the river, at the point now occupied by the main I am describing. Advertisements were sent out to engineers and contractors, asking bids for putting a 12 inch main across the river. A large number of bids were received ranging from $12 to $32 per lineal foot. This extravagant and widely varying bidding only served to show how little prepared, at that time, were the bidders for correctly estimating such work, [the lowest bid being more than one hundred per cent too high] and how prone they were to hedge it about with imaginary difficulties. The writer was sick at the time and did not know of the letting. The board rejected all the bids and it was sometime before any further action was taken. About two years later the board again moved in the matter, concluding not to advertise for bids but to do the work within themselves, and proceeded to construct a light wrought iron pipe, 12 inches in diameter, and laid it across the river at the point now occupied by the present 16 inch main. But little effort was made to prepare any trench in the bed of the river for this pipe, and the sections of pipe being flanged and joined together with bolts, it was difficult to lay the pipe so as to conform to the shape of the river bed, and hence it was not possible to secure a uniform and firm bearing upon the bed of the stream. This, added to the fact that the pipe was of light weight, rendered it very liable to displacement, as its powers of resistance to moving objects was not great. This main, however, did good service until the famous log jam of 1883 rendered it nonserviceable. In July last, the Board of Public Works again advertised for bids for laying a water main in place of the main that had given out. These plans called for a cast iron main, 16 inches in diameter, to be put together with lead joints, and the pipe was required

to be imbedded in the rocky bottom of the river, and covered over. There was but one bid received by the board in response to this advertisement, and that an extravagant one, which seemed to indicate that engineers and contractors were still somewhat afraid of the work. The board not choosing to award the work on a simple bid, at once re-advertised, and upon this latter occasion, the writer was requested to made a tender for the work. I went to Grand Rapids and made a careful investigation of the situation. I found that the river bottom, where the new main was to cross, was composed of stratified limestone rock and that drilling and blasting would be required in making the pipe trench. I made a bid for the work at $5.50 per lineal foot for the river section and 65 cents per foot for the land portion. This included the removal of the old wrought iron main. The city was to furnish the new pipe and the contractor to furnish every thing else and do the work. There were but two bids at this second letting, my own and a bid from the same party who bid at the first advertised letting. This bid, $8 per foot, was 50 cents higher than upon the previous occasion, which seemed to indicate that the bidder entertained grave fears as to the feasibility of the work. The work was promptly awarded to me by the board and I at once commenced operations. I first removed the old wrought iron main and then cleared away the slight accumulation of sand, gravel and fragmentary rock for the space of about 6 feet in width, on the line the new main was to occcupy, and entirely across the river, thus exposing the naked limestone rock. A false work was then constructed directly over this line, and entirely across the river. This false work was composed of about 70 trestles placed at intervals of 12 feet, or one trestle to each length of pipe. These trestles were connected together in such a manner as to make a good working bridge from which to prosecute the work. The chief purpose of this false work, was to serve as a temporary bridge upon which to lower it to place in the bed of the river, but it also served an excellent purpose as a base from which to conduct the trenching operations. This bridge was 8 feet in height, and ordinarily projected from 2 to 4 feet, above the water, although at times the water was up to the floor plank.

The plan adopted for making the trench for the main, was first to clean off the sand and gravel, as already described, thus exposing the naked rock, then to drill holes at intervals of 2 feet, on the center line of the proposed trench. These holes were carried to the depth of about 30 inches, and after being completed, were each charged with a one-half pound cartridge of hercules powder; these charges were prepared in clusters of six, and exploded with electricity, a small dynamo being used for the purpose. Inserted in the upper end of each cartridge, was an exploding cap, attached to which were two insulated copper wires, of sufficient length to reach above the water, where they were connected with the wires leading to the dynamo; this dynamo was of sufficient power to explode the six charges simultaneously, and could be easily

moved from one point to another, as occasion required, and it was not necessary to station it more than 50 feet from the blasts. It was not difficult to so adjust the charges as to secure the desired execution without the false work. This very greatly facilitated operations, as without the false work, for a working base, a very great amount of time would have been lost in getting to, and from the work. The blasts did the best execution when the drill holes were slightly inclined from the perpendicular. In charging the blasts, the cartridges were inserted in the drill holes, and forced to the bottom with a long rod. The overlying water proved to be sufficient packing to secure the desired execution, without sand tamping, and at the same time leave the false work free from danger from flying rock. The rock, though sufficiently broken up to permit of easy removal, still remained in the trench, from which it was simply raked out upon the sides, until after the main was laid, when it was raked back again into the trench, and over the pipe, heavy long handled hoes being used for this purpose. The trench when finished, was in most excellent form to receive the main; from each side of the river towards the center, the bottom of the trench sloped gradually for 300 feet, the entire fall being only 1 foot, while the middle section of 200 feet, was a true level. It is very rarely indeed, that we can obtain such an even grade entirely across so wide a river. After the trench was complete, and in readiness, the pipe was put in place upon the false work, and joined together, preparatory to lowering it to place in the bottom of the main. The pipe was of cast iron, in 12 feet lengths, each section weighing 1500 pounds, and of the pattern known as socket, and spigot pipe. The pipe was coated with Dr. Angus Smith's patent varnish, and the joints were made of lump gasket and lead. I gave the joints the greatest depth of lead the socket would permit, in order to secure the highest degree of lateral stiffness. In putting the line together upon the false work, it was so put together as to conform to the shape of the trench bottom, so that when lowered to place, the main would come to a bearing upon the trench bottom, simultaneously, throughout its entire length. When the main was all in place upon the false work, and the joints all made, chain slings were attached to it at intervals of 24 feet, or each alternate section of pipe, and to these chain slings were attached screw-rods, 1¼ inches in diameter and 9 feet long. These screw-rods were each provided with a double hook at the lower end, and to these the chain slings were attached, the rods, passing upward through a heavy supporting cross timber, were held in place by nuts, with lever extensions for turning them. These chains and rods were of proof metal, and capable of carrying sixteen times the load that was placed upon them. I provided this very large safety factor in order to be prepared for every possible contingency. While it was not at all probable, yet it was possible, we might not be able to secure equal duty along the entire line in lowering the main. Of course, if one chain and screw, from any cause, failed to carry its proper load, its neighbor would be overloaded.

After the slings and screws were all attached, the two shore ends of the main were flagged and braced, and the main filled with water, and subjected to a test process, of 140 pounds to the square inch. The result of this test was satisfactory to all concerned. After this test the water was all drawn from the pipe, as it was deemed best not to carry this extra load in lowering the main to place.

All was now in readiness for the grand climax of the entire work. In a few hours we were to know from *actual, practical* demonstration, whether our plans were to prove a success; whether our *theory* and our *practice* would prove harmonious.

The work had been observed with deep interest by the Board of Public Works, and by the citizens of Grand Rapids, and very naturally there were many doubts and fears concerning its successful accomplishment. The prevalent fear seemed to be, that it was impracticable to handle so lengthy and heavy a line of pipe all at once, and that even if this could be done, it would be impossible to resist the force of the current when the line became exposed to it. From my own point of view, I had considered all serious obstacles overcome when the *rock trench* was completed, and that lowering the pipe to its place in the bottom of the river would be a mere play spell, (and so it proved.) Of course I had carefully calculated the requirements of the situation, and the means requisite for handling the main, and for resisting the force of the current, and had provided amply, for any and all contingencies. And this was not a difficult matter at all. There were no unknown quantities involved. Everything could be mathematically demonstrated, almost as easily as two and two make four. If 50 feet of pipe could be handled safely all at once, *five miles* could be handled as safely if everything was *proportioned* and *timed* correctly. As to the great *bug-bear*, the current of the river, five minutes cyphering clearly demonstrated that *gravity* alone gave an ample factor of safety. The simple weight of our main being such that the current would not affect the line in the slightest degree. These fears and doubts proved quite a disturbing element with many who were very greatly interested in the success of the work, and they were not allayed until the work was fully completed, and they were shown to be entirely groundless.

Forty men were now stationed along the line of main, one at each screw, and a signal man with a horn was placed in the center. At intervals of ten seconds the signal man gave one blast with his horn, upon which the men at the screws each made one full turn of the screw lever at which he was stationed. We first made a few turns to the right, until the main was raised sufficiently to permit of the removal of the temporary supports from under the pipe. We then reversed and turned steadily and uniformly until the main reached its final resting place in the bed of the river. Two hours and a half only have been occupied in accomplishing this task, and our main now rests in its rocky trench at the bottom of the river with the entire volume of the river quietly flowing *over* it, instead of, as a few hours before quietly flowing *under* it.

While the trench in the bottom of the river was in excellent shape, yet I left all the screws attached and under partial tension, until the trench was partly re-filled and the pipe firmly bedded, after which the screws and chains were removed, the re-filling of the trench completed, the false work taken out, and now nothing remains in sight to indicate the scene of our recent busy operations.

The main was again tested after it was lowered to place, and found to have sustained no injury in the process of laying.

The plan here authorized for crossing rivers with water mains, is superior to any with which I am familiar, and if properly executed, will always ensure successful and satisfactory results.

A word here relative to the best kind of pipe, and joint for such work, will perhaps be appropriate.

I think cast iron is far superior to any other kind of pipe for such work. It is heavier and more durable. For river work heavier pipe should be used than for ordinary work, to insure safety from breakage under pressure. While it is urged that our river mains are no more likely to break than our street mains, other things equal, yet, if a break should occur in the river, it is a vastly more serious matter, and much more difficult and expensive to repair. We should therefore aim to be as secure as possible in each case. Lead joints are far superior to any other for this kind of work, as a properly made lead joint will permit of sufficient movement without any impairment of the joint, to allow for the expansion and contraction due to changes of temperature. It is also better to provide deeper sockets in the pipe used for such work. Pipe can readily be put together with lead joints in such a manner as to conform to, if desired, the irregularities of the ordinary stream bed, and a lead joint properly made, is more durable than any other.

W. R. COATS, C. & S. E.

Kalamazoo, January 1887.

A vote of thanks was given Mr. Coats for his paper.

The following paper on Thatcher's Slide Rule by Prof. J. B. Davis, was then read by the Vice-President:

THATCHER'S SLIDE RULE.

Gentlemen:

There has been brought to my notice during the past year a Slide Rule, devised by Edwin Thatcher, Chief Engineer of the Keystone Bridge Company, of Pittsburgh. It is the most useful and practical of any slide rule of which I have any knowledge. It is of sufficient extent to give results exactly to four places of figures and usually to five. It

will perform all the ordinary operations of arithmetic with great ease and comfort. In the making of tables the entries in which contain a common fraction, it is astonishing how it saves time.

As an illustration: Suppose one wished to make the much used table of inches reduced to decimals of a foot and advancing by sixteenths of an inch. A single setting of the slide rule is sufficient for writing out the whole table, however long we choose to make it. The same is true of any similar work, as taking out weights of iron for truss work—and the like.

This rule uses factors involving roots and powers—perfectly to the cube root and power, and indirectly to the higher ones. Above the second power and root, it is, however, not as direct in working as with factors of the first and second powers. But it is the great drudgery saver of all ordinary computations.

Whoever has much computing to do can now save himself the dreaded drudgery thereof.

This slide rule is in use already in hundreds of counting-rooms, engineer's offices, bridgeworks, and similar places. It is useful *anywhere* where computation of any ordinary kind, relating to accounts, averages, interest, estimates of stresses or materials, and the like, have to be made. It is not the wonderful calculating machine that will show the formulas of the calculus with a factor of precision suitable for the place logarithms and which nobody can own or run, but a simple drudge to help us all along with our common everyday drudgery, that anybody can learn and use whether he knows mathematics or not. I am sure from experience, repeated, that the inventor's estimate of one half hours time is ample for learning to *begin* to use it. I am likewise sure ten minutes is enough, if a person who knows the rule, can give aid to one who does not. Once the beginning is made it is simply a gradual progress to any duty. There is a good book with every rule giving suitable instructions for solving problems up to bridge stresses and column formulas. It will figure beams and all such work. And best of all, but not least, the price is $30.00 instead of $150.00, which such a device is well worth. Yes—more than that in any office where it can be kept at work pretty steadily as it will do the work of a number of computers—*and*—it's work is right.

I have placed my rule on exhibition for the members to see and all are quite welcome to examine and use it. One is soon struck with its simplicity and perfection. One is more struck with the really astonishing speed with which an experienced person rolls (literally) out the results.

The report of the Committee on State Boundaries, prepared by Burton Kent, was then read by L. F. Rogers. In this report Mr. Kent gives the results of his investigations in regard to the boun-

dary line between Michigan and the states of Ohio and Indiana, which may be summarized as follows:

So far as he can learn there has been no serious difficulty in locating the Michigan and Indiana line. That line is also used as the closing line of the United States surveys in both Michigan and Indiana and marked as such. The line being used as farm boundaries has been as well kept by the interested land owners as such lines usually are. Between Michigan and Ohio the case is different. The boundary was located subsequent to the United States surveys and does not follow the lines, but crosses them. The survey of the boundary line shows its connection with the government survey, and the distances of the intersection of section lines from the nearest corners.

In a few instances difficulty has arisen in locating the state line but as it is not frequently used as a farm boundary, it is generally regarded with indifference and no attempt made to find or preserve it. In view of the perishable nature of the marks on the ground along the line and the loss of many of the stakes and witness trees, the committee think it would be the part of wisdom to take some action looking to the proper marking and monumenting of the line.

The discussion of the report by the society brought out the opinion that the most effective way to secure the necessary action by the legislature would be by memorials from the boards of supervisors of the counties interested. The report of the committee was adopted.

Mr. W. F. Gurley, of Troy, N. Y., then explained to the society, the new features contained in the instruments exhibited by the firm represented by him.

He was followed by Mr. Holmes, in the afternoon session. who explained his Solar Theodolite, calling attention to its prominent features.

The Special Committee then submitted the following report which was accepted and adopted:

NATIONAL CIVIL PUBLIC WORKS.

Mr. Chairman and Gentlemen of the Michigan Engineering Society:

Your committee to whom was referred the reports and papers of the chairman of the National Civil Public Works Committee, respectfully report as follows:

That, first, the treasurer be instructed to pay the chairman of the national civil committee, for expenses incurred by the said committee, and we also recommend that each member be requested to subscribe $1 to provide a fund to meet the further expenses of said committee.

We also recommend that the old committee be continued, and that the president be authorized at any time, to fill by appointment any vacancies that may occur in this committee.

W. R. COATS.
E. TREADWELL.
GEO. A. MARKS.

The following is the report referred to.

The temporary committee of the Engineering Societies of the United States, of which an account was given at our last convention, passed out of existence on April 1st, 1886, when the permanent organization of the Engineering Societies of the United States, for the purpose of forwarding the reform in the methods of conducting our National Civil Public Works, under the title of The Council of Engineering Societies on National Public Works, was completed according to the original design. This Council was organized at Cleveland, Ohio, by delegates from the various Engineering Societies in session March 31st and April 1st, 1886. The officers are:

L. E. Cooley, President, Chicago, Illinois.

J. B. Davis, Vice President, Ann Arbor, Michigan.

John Eisenmann, Secretary and Treasurer, Cleveland, Ohio.

An Executive Board of four additional members was created, mamely:

Augustus Kurth, Brooklyn, N. Y.

L. M. Haupt, Philadelphia, Pennsylvania.

R. E. McMath, St. Louis, Mo.

Louis J. Barrot, Charleston, S. C.

Your committee was not present at this time, although urgently requested to be, because it was not practicable for its chairman to attend. It being demonstrated that no legislation could be obtained at the session of Congress then sitting, the Executive Board devoted its attention to obtaining information by means of the committees of the council and to securing support from the various societies creating said council. In deference to this policy your committee attempted its part of the work last named, and prepared and distributed a circular to the members of this society, asking for a contribution of $1.00 per member. Upwards of 200 of these circulars were sent out. The result has, so far, been $20.00. By this means your committee have been made aware of the interest of our members in this work. This sum has not been forwarded yet in the hope that it would be very materially increased as we certainly should bear our share in the labors for this much needed reform, otherwise the day will surely come when we shall regret it. We

certainly should bear our share of the expenses already incurred. Your committee hope this will be promptly done and that our society will continue its connection with this great enterprise—a fitting labor for the most eminent as well as the humblest in the profession to which we belong. Your chairman of this committee regrets exceedingly that his other affairs oblige him to signify his unwilling request to be relieved from further duty in this work should there be any desire to have the old committee continued. Whatever the wishes of our society may be, I hope they will be plainly signified, in order that the Council of Engineer-Societies may be in no doubt as to the resources at their command. So far as known to the chairman the only expenses of the committee have been $22.20 as per accounts herewith submitted.

There seems to be need of some further action in regard to this expense as the secretary, Prof. R. C. Carpenter, thought no provisions had been made for any expenses by this committee, while your chairman is quite certain, he was not prepared to accept his position had he understood these to be the terms.

Respectfully submitted,

J. B. DAVIS, Chairman.

FINANCIAL STATEMENT.

1886.

4–5	Received from	R. C. Carpenter,	$6 00
5–7	" "	G. F. Allmendinger,	1 00
	" "	Burton Kent,	1 00
4–10	" "	J. A. Mitchell,	1 00
4–10	" "	C. E. Mitchell,	1 00
	" "	A. L. Reed,	1 00
	" "	Geo. E. Steele;	1 00
5–1	Notice from R. C. Carpenter of additional,		6 00
	Books show $2,00 more,		2 00
	Total,		$20 00

EXPENSES.

2–9	Circulars,	$ 2 50
	Envelopes	2 40
3–4 to 6	Trip to Cleveland,	17 30
	Total	$22 20

This account is correct.

J. B. DAVIS.

Committees were appointed as follows:

1st. On Instruments—H. D. Rothwell, Job Tuthill, M. H. Bailey.

2nd. On Nominations—C. E. Greene, C. F. R. Bellows, Wm. Appleton.

3rd. On President Davis' Suggestions—A. L. Drew, F. Hodgman, L. F. Rogers.

4th. On Vice President's Address—H. A. Collar, J. Ripley, L. Hemingway.

Capt. W. L. Coffinberry, with a suitable address, presented the society with an English Standard Boxwood Scale, four feet long. Also a metal protractor made by Fields, of London, graduated to 360° with radial arms, having on each arm a vernier reading to minutes. From information in possession of the donor, he believed these instruments to be at least 150 years old. The articles were to remain in the possession of H. A. Collar, City Engineer of Grand Rapids, until the society is incorporated and entitled to possess property.

The society, by a unanimous vote, tendered their thanks for the valuable gifts.

The committee on Manual made a statement that a full report was furnished to be published in the proceedings of 1886. In addition to what was stated there, it might now be said that in round numbers the edition has cost $1.600. The price to members of this society has been placed at $1.75. A considerable number of the members have not as yet secured copies, and it is desirable that they do so at an early day to assist in carrying out the pledge of the society and in part to re-imburse Prof. Bellows for the money advanced by him in the publication.

Prof. Cooley gave an illustrated address on Gas Engines, which was not reported for publication.

ELECTION OF NEW MEMBERS.

The society then proceeded to the election of new members and to correct any errors which might have existed in the letter ballot. A ballot was taken and the following persons elected to membership:

No.	Name	Address.
1	Ames, Geo. M.	Pokagon, Cass county, Mich.
2	Almendinger, Geo. F.	Ann Arbor, Washtenaw county, Mich.
3	Barry, Edgar Frank	Detroit, Wayne county, Mich.
4	Burt, Hiram A.	Marquette, L. S.
5	Clements, Wm. L.	Bay City, Mich.

6 Dunlap, Frank M.....83 Brainard street, Detroit, Mich.
7 Gardam, Fred W.....96 John street, New York.
8 Johnson, John P. .....St. Louis, Mo. (Washington University).
9 Johnson, Thos. L.....2131 North 21st street, Philadelphia.
10 Kastl, Alex. E.....793 Michigan avenue, Detroit.
11 Taylor, Clarence G.....Ann Arbor, Mich.
12 Strong, T. C..... Bay City, Mich. (Industrial Works).
13 Wagner, Frank C.....Ann Arbor, Mich.
14 Whitten, Wm. U.....South Bend, Ind.
15 Wells, Milford N. .....Ann Arbor, Mich.
16 Dart, C. R.....Grand Rapids, Mich.
17 Christ, G. A..... ....40 Williams street, Grand Rapids, Mich.
18 Stimson, W. B.....Grand Rapids, Mich.
19 Sekell, A. C.....120 College avenue, Grand Rapids, Mich.
20 Tennant, G. B.....135 Fountain street, Grand Rapids, Mich.
21 Johnson, G. Stewart,.....Grand Rapids, Mich.
22 Petheram, James W.....Grand Rapids, Mich.
23 Wiseman, James,..... ...Agricultural College, Mich.
24 Forester, Thomas.....Williamston, Ingham county, Mich.
25 Mullet, John.....Williamston, Ingham county, Mich.
26 Strong, Edward.....Kalamazoo, Mich.

Fifteen new names were presented for membership to be voted on by letter ballot.

The committee on nominations reported:

For President, Geo. E. Steele, of Traverse City.
For Vice President, E. F. Guild, of East Saginaw.
For Secretary and Treasurer, F. Hodgman, of Climax.
For Assistant Secretary, Geo. S. Pierson, of Kalamazoo.

The report was laid on the table until Thursday.

EVENING SESSION.

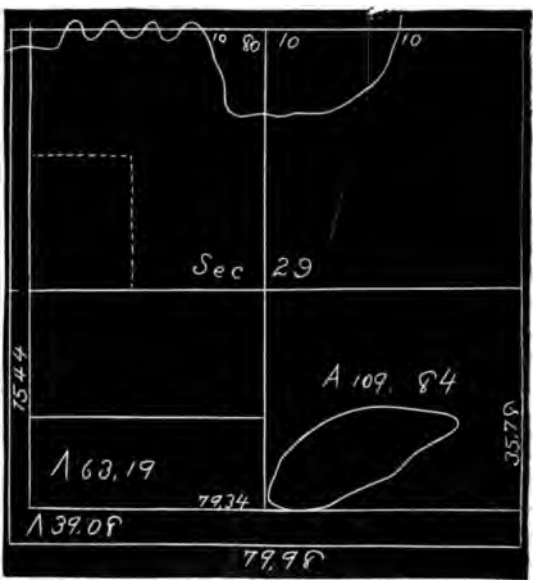
Mr. F. Hodgman read the following paper:

A LAND CASE IN OUR SUPREME COURT.

A case has been recently decided in the Supreme Court of this state in which some of the principles laid down are so much at variance with those commonly accepted and followed by good surveyors that I venture to call the attention of the society to the case and make a few comments on it from the surveyor's standpoint.

The case is that of Keyser vs. Sutherland, brought up from the Kalamazoo circuit.

Where the city of Kalamazoo now stands, there was once an Indian reservation known as the Matche-ben-ashewish Reserve. It contained nine square miles taken nearly out of the center of Township 2 South, Range 11 West. It was in the form of a square, three miles on a side, nearly corresponding with the section lines but not quite. Its relation to the section line was very much as though the boundary lines of nine sections had been moved bodily a few rods to the northeast.



The figure is a correct copy of the government plat of this territory except that the dotted line has been added.

The exterior boundaries of the township as well as the boundary of the reserve were run and marked by John Mullett, in November 1825. In January 1827, he subdivided the township. As the subdivision lines did not correspond exactly with the reserve boundary, they were closed on it and posts set at the intersections, except on the west line of the reserve where the distance between lines being less than one chain, no posts were planted on the reserve. This left a series of fractional sections all around the reserve, those on the north and east of the reserve being nearly full sections, while those on the south and west were very small, containing less than 80 acres each.

These small sections were not subdivided, but each returned and marked on the plat as a single lot, and the area given. At a later date the Indian title was extinguished and in June 1829, Orange Risdon subdivided the reserve, connecting his lines with the subdivision lines of the

township previously marked. The sections were numbered the same as if there had never been any reserve. No mention is made by Risdon of the west line of the reserve, which Mullett had closed his lines upon without setting posts at the intersections. The fractional section adjoining the Southwest corner of the reserve (as originally returned) was peculiar in shape as the reserve took nearly the whole of it, but left a narrow strip running along and adjoining the South and West sides of the reserve. This narrow strip like an L, each arm of which was a mile long, was returned in the plats as a single fraction containing 39.08 acres. This fraction was sold by the United States and described as the South fraction of Section 29. The south arm of the fraction was four chains wide while the west arm was less than one chain wide. The United States also sold the S. W. ¼ of the N. W. ¼ of Sec. 29, making no mention of it as a fractional lot, and it is not shown as such on the plat, except that the fraction lying west of the reserve line is distinctly marked and the area given.

The land in dispute is that portion of the fractional section lying

ERRATA.

Owing to the inability of the Secretary to give a close personal supervision to the preparation and make-up of the proceedings, several errors have escaped attention until too late for correction. These will, for the most part, be readily detected and corrected by the reader. The figure on the opposite page by an error in the make-up is not in its proper place, tending to mislead the reader, it represents not the whole reserve, but Section 29 only.

puted land and in so doing the case came to our Supreme Court. Judge Morse, in giving the opinion of the court, among other things says:

"As a matter of law, this patent issued by the United States to Barnard, and purporting to convey the lot or South Fraction of Sec. 29, does not include the strip of land here in dispute. The land in controversy lies entirely North of the quarter line running East and West through the section and is therefore on the North half of the section. The South fraction cannot be construed as continuing any further North than the East and West quarter line of the section. Under the Statutes of Feb. 11, 1805 and April 24, 1820, the Surveyor General had no authority to extend a South fraction North of the East and West quarter line. If he did so it was in violation of law and contrary to the duties of his office, and therefore void."

References are given to the cases of:

Brown's lessees vs. Clements, 3 Howard, 650.
Miller vs. Ker, 7 Wheaton, 1.

The remainder of the rulings in this case I do not discuss, but it does seem as if that which I have quoted calls for attention, as it tends to unsettle titles in almost every township in Michigan which has fractional lots bordering on rivers or lakes. The decision unsettles 55 titles in Kalamazoo county alone, aside from the reserve fractions.

You will observe that the point is, that the Surveyor General had no authority to extend these fractions beyond the quarter lines. Now, whether he had the authority or not, he did it, and it has been the uniform practice of the department from its first organization down to the present day to do that very thing. Almost innumerable South fractions have been made extending North of the quarter line and vice versa. The land has been sold by the government and is held to-day in that way.

It seems strange that such a practice should continue so long and still continue if it was without warrant or proper authority.

If it is true that the Surveyor General has no authority, under the acts quoted, to return this lot in the way he did, and if it is true that so returning it was contrary to the duties of his office, doubtless the court was correct in the opinion that the action was void.

But are these propositions true?

Let us look into it a little. First, let us take the particular case in question.

It will be noticed that when the plat of this township was made up, this lot of land, afterward sold as the South fraction of Sec. 29, was all there was of section 29. So far as that was concerned, the remainder or Indian reserve, might as well have been a lake. It (the fraction) was section 29 itself, and contained less than 160 acres. Now, looking at the act of 1820 I find the following language:

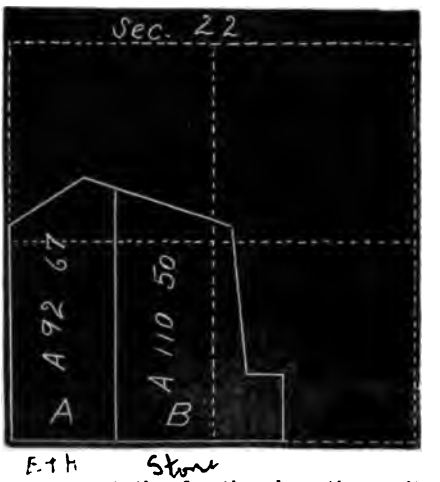
"In every case of the division of a quarter section the line thereof shall run North and South and *fractional sections* containing 160 acres and upwards, shall in like manner as nearly as practicable, be subdivided into half quarter sections under such rules and regulations as may be prescribed by the Secretary of the Treasury, but fractional sections containing less than 160 acres *shall not be divided.*"

Now here was a fractional section which, at the time the survey and plat was made, contained less than 160 acres, and it would look to a surveyor that the Statute of 1820, not only authorized the Surveyor General to return this particular tract in the form that he did return it, but actually forbade him to divide it or return it in any other way. It does not seem to me to make any difference, the fact that two years later the lacking portion was added making a full section, so long as the original fractional section 29 was retained on the plat in just the form in which it was originally returned.

But the Court cites the authority of the Supreme Court of the United States in support of the ruling, referring to the case of Brown's lessees vs. Clements, 3d Howard, 650,

For the purpose of making the whole subject as plain as possible I give a brief statement of the points in that case.

The dispute arose over the division of a fractional section 22, Town 4 South, Range 1 West, in Mobile, Alabama. The section was made fractional by private land claims, and unlike our case contained something over 160 acres. The form of the section was something like the figure.



The full lines represent the fractional section as it was subdivided and returned upon the plat by the Surveyor General. The broken lines show the quarter lines and the boundaries of the section as they would have been if extended over the private land claims.

Ethridge and Stone lived on this section previous to the survey and filed preemption claims. When the land came into market, Ethridge purchased the west lot on which he was living, which was patented to him as the *S. W. Qr. of Sec. 22, containing 92.67 Acres*, for which he paid $1.25 per acre $115.83. Stone purchased the east lot which was patented to him as the *S.E. Subdv. Qr. Sec. 22, containing 110.50 Acres*, for which he paid $1.25 per acre $138.13. Here was a case in which the fractions as returned extended beyond the quarter lines both on the North and East.

The grantees of Ethridge, under his patent, claimed the whole of the S. W. ¼ as it would have been if the quarter section lines had been extended across the fraction. The Supreme Court of the United States passed upon the claim in the case quoted, Brown's lessees vs. Clements. In passing on it the court says:

"There is nothing in any of the Acts of Congress nor in the instructions of the Secretary of the Treasury to authorize the division of this fractional section made by the Surveyor General, and it being contrary to the duties of his office it must be regarded as a void act."

And although Stone's was a prior title, the land was taken from him

who had bought and paid for it and given to Ethridge (by his grantee) who never did buy or pay for it.

It is considered presumptuous for a private citizen, surveyor or otherwise, to criticise the rulings of a Supreme Court, no matter how wrong it looks. Fortunately, in this case, it is not necessary and I leave the criticism to the court itself.

The case of Brown Lessees vs. Clements was decided in 1845, several of the Judges strongly dissenting from the decision. In 1858 the identical same tract of land came in question again. This time it was Gazzam vs. Phillips' lessee and others.

Reported in 20th Howard, 372.

I quote the following extracts from the decision in the case. Speaking of the sales to Stone and Ethridge the Court says;

"The sales in each case were made in conformity with the plat of the survey then on file in his office," etc.

"We deny altogether the right of the court in this action to go beyond these terms thus explicit and specific and under a supposed equity in favor of Ethridge arising out of the pre-emption laws to the whole of the Southwest quarter enlarge the description in the grant, or more accurately speaking, determine the tract and quantity of the land granted by this supposed equity instead of by the description of the patent.

"We are not satisfied that there was any want of power in the Surveyor General in making subdivisions of this section according to the plat and in conformity with which the sales of the lands in dispute were made.

"The Act of 1820 provides that fractional sections containing 160 acres and upwards shall in like manner, as nearly as practicable, be subdivided into half quarter sections under such rules and regulations as may be prescribed by the Secretary of the Treasury.

"The Secretary of the Treasury, on the 10th of June following the passage of the act, issued regulations through the Commissioner of the Land Office, directing fractional sections containing more than 160 acres to be divided by North and South or East and West lines, so as to preserve the most compact and convenient form. This section was divided by a North and South line according to these instructions. The question came before the Secretary of the Treasury and before us in 1837 and the construction first given and the practice of the Surveyor General under it confirmed. Attorney General Butler in a well considered opinion observed: 'If Congress had intended that fractional sections should at all events be divided into half quarter sections when their shape permitted the formation of such a subdivision, I think they would have said so in explicit terms, and that the discretionary power entrusted to the Secretary would have been plainly confined to the residuary parts of the section. And further that the clause in the first section of the act of

1820, concerning fractional sections containing less than 160 acres (which are not to be divided at all) is decisive to show that congress * * did not deem it indispensible that regular half quarter sections should in all practicable cases be formed by the surveyors. On the contrary, it shows that they preferred a single tract though containing more than 80 acres to small inconvenient fractions." The court adds: "We entirely concur in this construction of the act," and further goes on to say: "The only difficulty we have had in this case arises from the circumstance that a different opinion was expressed by a majority of this court in the case of Brown's Lessees vs. Clement, 3 How. 650."

"It is possible some rights may be disturbed by refusing to follow the opinion expressed in that case, but we are satisfied that far less inconvenience will result from this dissent than by adhering to a principle which we think unsound and which in its practical operation will unsettle the surveys and subdivisions of fractional sections of the public land running through a period of some 28 years. We cannot adopt that decision or apply its principles in rendering the judgment of the court in this case."

So said the Supreme Court of the United States in 1858. Its statements seem sufficiently plain and specific. So far as I can learn, this descision stands to-day the authoritative ruling of the highest court of the land upon this point. Whether the Supreme Court of Michigan will follow the example of the Supreme Court of the United States by taking the first opportunity to right a wrong decision remains to be seen. It is not every court that is able to rise to the occasion and reverse the rulings of one of its own decisions no matter how erroneous that ruling may be.

NOTE.- Since the above article was written, the attention of the writer has been called to the case of Clute vs. Fisher, more recently decided by the Supreme Court of Michigan, and reported in the Northwestern Reporter Vol. 31, p 614. The doctrine laid down in the case of Keyser vs. Sutherland, to which attention is called in the foregoing paper, is re-affirmed. The decision is interesting to surveyors as answering the question, several times raised in this society, as to how lot lines are to be extended under the meandered waters or beyond the meander lines of the lakes in this state. It sweeps away at a single brush, all those questions of riparian ownership which Judge Cooley, in his address before this Society, considered so difficult of solution, and wonderfully simplifies the work of the surveyor. In this case one of the parties went out upon a meandered lake and cut and drew away a load of ice after being forbidden to do so by the owner of the adjoining land. The result was a lawsuit, in deciding which, the Supreme Court lays down the very convenient doctrine for surveyors shown in the following extracts:

"The soil under water in this state does not belong to the general government or to the state." "Private ownership of lands bounded by navigable fresh water is not restricted to the meander line. This doctrine must apply also to the small inland lakes of this state by analogy whether they can strictly be termed navigable or not."

"Neither the United States nor the state of Michigan owns the bed of this lake which is a small body of water, (lying almost wholly in Sections 14 and 23 with a small corner in Section 24). Nor can any person owning land described as a subdivision fractional, or otherwise, of any section other than 14 or 23, hold any title to the soil under this lake within the lines of said Sections 14 and 23, by virtue of being a riparian owner of the bank of the lake upon some other section, or otherwise."

"The true and only rule is to invest the holder of the title of any fractional subdivision of a section bordering on the lake, with the ownership of the bed of the lake to the lines of said subdivision, as they would be if continued through or into the lake."

SPECIFICATIONS FOR THE NEW STEEL CRUISERS.

Prof. M. E. Cooley read from the printed specifications issued by the United States Government, some of the specifications for the new steel cruisers.

Mr. Hodgman—Are the specifications for the armor given there?

Prof. Cooley—They are not. I would say in regard to that, that thus far no armor has been produced which can withstand the power of the modern projectile. Guns are now built which throw a projectile through two feet of solid iron, as firmly packed as possible.

Mr. Hodgman—I raised the question because I wished to learn what kind of armor was required. I am not well posted on this subject, but it has seemed to me for many years that the armor builders were on the wrong track. So far as I have been able to learn from my reading, the effort thus far seems to have been to build up a thick solid mass of metal, supported as firmly as possible so as to present an unyielding surface to the impact of the projectile. If I am correct in this, it seems to me the principle is most unsound. I think the aim should be to present an elastic, yielding surface that will not present its greatest resistance at the instant of inpact, but yield to the blow and expend its force gradually. Every axeman knows that it is easier to cut off a limb close to the tree where it is unyielding, than it is to cut it off at a point where it yields to every blow. Every carpenter knows that it is far easier to drive a nail into a dry hard wood board if it is firmly supported than it is when the board gives at every blow. It seems to me these immense heavy masses of iron are very far from being the best resistants. The armor should be yielding, absorbing the power of the blow gradually, not solid. Its backing should also be of some substance like cork or hair which will not fracture and split to pieces, but like the armor itself, gradually absorb the power of the projectile without flying to pieces. It looks to a surveyor back in

the country as though when the armor men begin to work in this direction they will not find it a difficult matter to make an armor which will at once be very much lighter than the present style of armor and at the same time resist effectually the impact of any projectile that can be thrown against it.

Prof. Cooley—Successful experiments have been made in the use of cork for armor.

Mr. Bartholomew gave an instance of the cutting away of the iron sheeting of the vault in the old state house which was found to be a very difficult task on account of the loose backing, permitting the plate to yield to the blows.

AMENDMENTS TO THE CONSTITUTION.

The report of the Committee on Amendments to the Constitution was then taken from the table and the first clause of the report relating to membership fees was unanimously adopted as follows: In Section one—third line—strike out the word *two* before dollars and insert the word *five*. The effect of this amendment is to raise the membership fee to $5.

It was then voted to hold the next meeting at Kalamazoo.

A resolution relating to incorporating the Society was introduced by Mr. Drew and laid on the table till Thursday morning.

THURSDAY'S SESSION.

The resolution relative to incorporation was taken from the table and adopted as follows:

WHEREAS, It is desirable that this society should be incorporated so that we may have a legal existence, Therefore be it

Resolved, That the President and Secretary are directed to procure the incorporation of this society under the name and title of the Michigan Engineering Society, and further, the Secretary is instructed to procure a suitable seal for the use of the society, the cost to be defrayed out of any moneys in the treasury.

On motion of Mr. Appleton, the resolution was referred to the Executive Committee with power to act.

On motion of Geo. A. Mark, the report of the special committee on National Civil Public Works, consisting of W. R. Coats, E. Treadwell, and Geo. A. Mark, was taken from the file and amended in accordance with the following resolution:

On further consideration—

Resolved, That whatever moneys may be received from the members of this society, in contributions of one dollar each, or more, over and above the regular dues, be applied to the support of the Council of Engineering Societies on National Public works, and that the expenses incurred by our delegate in attending the meetings of this council be paid from the general fund.

SUGGESTIONS OF PRESIDENT DAVIS.

VESSELS.

The vessel interests of our state are among the most important of its commercial resources. We have among our members some especially interested in constructions of this kind. It seems to be important to have the gentlemen in these pursuits encouraged to add themselves to our membership. Our lake marine is developing a special construction adapted to the requirements of lake commerce. I am sure the mechanical problems are of the deepest commercial and scientific interest. I am informed that our state contains some of the best men engaged in this line of work. I shall be glad to welcome them to our society and hope they will be able to add to the profit of our organization their experience and views. I should much like to hear from them upon the subject of vessel propulsion in reference to which there now appears renewed activity. I would like their views upon desirable models for our carrying trade. Have we some noble vessels that are unmanageable in heavy weather? I am confident these men can, out of the richness of their experience and study, add much that is of the highest consequence to our sessions. It is a pleasure to contemplate the work of their hands and heads in the noble vessels now afloat. It will also be a great satisfaction to enjoy the benefits of active association with them and to learn from them. The naval constructors of this country are a noble race and have secured to us, as a nation, distinctions no other people can claim or can equal.

COMBINATION BIDS.

In our state, like every other, the people are made victims in various places, times and ways, of unfair bidding by contractors offering their services for the construction of work. Doubtless we all have met this thing in one form or another, may be in many forms. The eventual result of this must be better digested plans and complete working estimates and drawings by competent engineers who cannot be bought nor intimidated--men who will resign and make the true reasons therefor known rather than be party to any iniquity. The integrity of our profession is to be tried as never before. I look confidently to see it sustained. But many of our towns and cities are not yet prepared to adopt this course. In the mean time it seems to me an important duty of this society to suggest ways by which this difficulty may be met. One effectual way

of reducing the trouble, used in England, I understand, is to charge quite a handsome sum for the opportunity to bid, or for the copies of the requirements and specifications.

One form of unfair bidding is known as the "combination" or "pool" bid. This appears to be a lawful method on the part of bidders. They have the same right to fix the prices of their materials and work—so they claim—that the petroleum or any other pool has. The result to the buyers is the same—a price above the actual value of the work. This form of operation calls for simple intelligence and efficiency on the part of the consulting engineer. It undoubtedly calls for the engineer—which many parties have yet to recognize.

CONVICT LABOR.

Use criminal labor to build and maintain good highways, ditches and any public works. Increase the term of restraint or make it the full term permitted by law. Divide the time into two parts—the first purely punitive with a shortening for good behavior, with no pay—the second with pay, to be used by the public for maintaining those properly dependent on the person under restraint for support. The second part to be reformatory in character, with a view of liberating from restraint a useful member of society instead of a confirmed criminal. Organize a system of transfer of those under restraint from one field of work to a better class of work as well as from place to place or town to town where their labor can best be utilized. Make these transfers, rewards or disgraces, as the case may be. Use the females for labor suited to them. Have no idle criminals. Have no person sustained at public expense who is capable of self sustenance.

The committee to whom these suggestions were referred reported, favoring the admission of vessel builders to the society—reporting the convict labor question back to the society without recommendation—and saying that they see no remedy for the evils of combination bids which it is in the power of this society to enforce, and suggesting that Prof. Davis be requested to present his views on this subject to the society at its next meeting. The report was adopted.

The Society then proceeded to the election of officers, and the Secretary was instructed to cast the ballot for the Society, which he did, electing the persons named in the report of the nominating committee.

The committee on Vice President's address made the following report, which was adopted:

To the Members of the Michigan Engineering Society:

Your special committee to whom was referred the address of the Vice President report the following:

That a committee on Decisions be appointed as recommended, and respectfully nominate as that committee, Messrs. William Appleton, D. Skeels and M. H. Bailey.

For a committee on Machines and Construction, we respectfully refer the appointment of them to the President, in recognition of his better knowledge of the fabric of which the society is composed.

Initiative measures looking toward the incorporation of the Society are under consideration, therefore your committee make no recommendation in this regard.

We heartily commend all other suggestions contained in the address to members of the Society, and trust that they may be influenced to turn into the common fund much useful and valuable information.

Respectfully submitted,

H. A. COLLAR.
L. HEMINGWAY.
JOSEPH RIPLEY.

REPORT OF THE COMMITTEE ON INSTRUMENTS.

The Committee on Instruments made the following report which was adopted:

Mr. President and Gentlemen of the Society:

The firm of W. & L. E. Gurley, Troy, N. Y., exhibit the following instruments of their manufacture:

One 5 inch Engineer's transit.
One 5 inch D. V. Sur. transit with circle, level and clamp.
One 5½ S. V. Sur. transit with level and clamp.
One light mountain transit with level and clamp.
One 20 inch Y level.
One architects level.
One 4½ inch Ver. pocket compass with telescope attachment.
One 4½ inch Ver. R. R. compass with telescope attachment.
One reconnoisance transit.
One 6 inch surveyor's compass with telescope attachment.

This firm would desire to call attention to their improvements, viz.: The introduction of the single tangent screw with opposing spring

applied to the upper plates and the telescopic axis of transits and to the leveling heads of transits and Y levels.

The change in the position of the limb verniers of transit to an angle of 30° with the telescope is a marked improvement.

The rack and pinion movement to the eye piece, much needed in his former instruments.

The graduation of all limbs and verniers on silver, thus making a finer and more desirable division.

In fact, all his improvements are in the right direction, viz.: the making of the various instruments in general use by the profession which shall combine usefulness with lightness of weight and at a minimum of cost.

Mr. J. W. Holmes showed a new Solar Theodolite, which deserves more than a mere passing remark. It is an instrument of accuracy, and as such is by far the best that has been shown to the Society. Its facilities to correct and test its own adjustments are in every case duplicated. It combines in a most ingenious and compact manner all of the principles and properties of the solar compass with those of the ordinary engineer's level and transit or theodolite. This new instrument is, in our opinion, exceedingly well adapted for every variety of engineering field work, as it will perform with greater accuracy, all the functions of the above named different instruments.

The remarkable facility with which the true meridian and true time either from the sun or from some fixed star, are found with the utmost exactness, is a feature deserving particular notice and praise. This operation is performed in a very few minutes, so that survey lines can be referred as often as may be desired to the true meridian.

Another novel feature in the construction of this instrument is the ease and rapidity with which all its adjustments can be made by the engineer, without the aid of an assistant.

These very desirable and valuable qualities, together with its excellent workmanship cannot fail to commend it to the favor of all engineers and surveyors.

Mr. F. Hodgman, C. E., also presents a form of field book for general use in the field that fills a want long felt by the profession. Its chief features are combining with a field book the principal tables made use of by the surveyor in general practice, and having the paper ruled in cross sections convenient for sketching plats and for recording all kinds of notes for surveys and lines which the surveyor has to make in the field. It combines practical utility with neatness of form.

Mr. Thatcher's Calculating Instrument or Cylindrical Slide Rule. The value of this slide rule as a calculator, depends upon the accuracy of its results, upon the rapidity with which those results can be found, upon the variety of its useful applications and upon the small amount of mental and physical effort required in the solution of problems. The instrument shown to us can be used for almost all kinds of calculations, which it

performs with accuracy and speed. The manipulation of it is readily acquired and the useful applications of the instrument are as general as the fundamental rules of arithmetic.

Respectfully submitted,

HENRY G. ROTHWELL,
M. H. BAILEY.
JOB TUTHILL.

Mr. Watkins read the following paper on

THE ENGINEER, HIS POSITION AND DUTIES.

In presenting this paper little thought has been entertained of imparting instruction, especially to the older members, or assuming to be the mentor of the younger; but of hoping to so awaken the general interest for improvement, that studies if now neglected shall be resumed; that a more extensive and deeper examination into the why and the wherefore should be made of all problems; that an earnest enquiry shall be elicited by each member--what is it possible for me to add to the year's developments; with a willingness to perform all which may be attainable; if these objects shall be accomplished, then will the wishes of the writer have been fully met.

In looking abroad upon the world and contemplating the various changes and improvements from the past in the physical conditions of life, we are naturally led to enquire about the forces and agencies that have been employed in effecting the present superior condition of things, and also, about the class of men who have proved themselves equal to the emergencies of distributing those forces and controling their energies for ameliorating the lives of their fellow men.

Conspicuous among the contributors for these advanced, and still advancing conditions, and largely to be credited, are the engineers; let their work lie as it may in anyone of the special departments of the chosen profession; well for us of to-day is it that brilliant minds have in the past devoted their life works to effect this mighty change, this wonderful metamorphasis; are we to be heirs only of this heritage? or, are we to use it as being the proper lever in our hands to effect still greater achievements? if so, then must we put ourselves in suitable condition with our surroundings, being equiped with all available knowledge, bringing to bear the experiences of the past for the solutions of the problems of the present, and bequeathing these as data for those of the future. Undoubtedly there are now, as there have been in the past, men of superior endowments, possessing gifts above their fellows, imbued with especial fitness for the execution of works of great magnitude and usefulness; but I believe many, if not most of these gifts and so called

endowments, have been of their own bestowal: in other words, their own continued exertions properly directed have reverted upon the agents, creating this special preparation and fitness.

The engineers are pre-eminently the men who are to lay the foundations and build the bridges for the passage of the millions now delving in the toilsome heaths of the present for a livelihood to the elysion fields of the future, where the exertions for their daily sustenance will be but added pleasures of their being.

The engineer is in position between the earth, with its elements and its forces, and its people, to make two blades of grass grow where but one grew before; to fill the barns of the farmer with plenty; to relieve in a measure the patient ox in his toil of the furrow, and the ever serviceable horse from over exertions of the road; to assist workmen in all the avenues of life, by harnessing the elements for their relief; to give water to the thirsty land, and bid it depart from that which is submerged; to give light for darkness, and heat for cold; to make the afar near; to bring that which is high down, and to elevate that which is low; to make the elements which are at war, bow subservient to his wishes; to plant civilization where savagery endured; to make the wastes of the earth habitable, and the unknown places to send us greetings; to drive disease from our doors, and make life a blessing to all, rather than a curse to any; to lengthen the span of life, and to despoil the grave of its early victim; to give to a score of years the pleasures and experiences of a centure as measured by the past; to employ the forces of nature to create, as it were, a new heaven and a new earth, that the inhabitants thereof shall enjoy pleasure instead of pain; that an abundance and happiness shall be dipsensed where poverty and wretchedness presided; that knowledge shall reign where ignorance was wont to abode; and intelligence sit enthroned where superstition bore rule.

Such is but a faint portrayal of what the present and the future may open up at the hands of the engineer; and where much is give, assuredly much should be required; are we prepared, or preparing to render accordingly? will we be faithful to the trust, and add to the legacy before our departure? will the new field in which we may tread on the morrow be traversed with more skill, learning and ability because of weil discharged duties of to-day? Every advancement to a higher plane gives a broader view, a more extended horizon for investigation, in which new problems will be presented to be overcome only by faithful study of their phases and patient industry. By way of illustration let me call to your remembrance, that one year ago our seventh annual meeting was held at the seat of the empire for learning in our State, the University at Ann Arbor; and among the things to be seen there of interest for gratification and instruction were her water works. By courtesy we were enabled to partake of a sleighride to the receiving reservoir and to the fountain head in close proximity; we were not only surprised, but completely astonished at its apparent insignificance for the purposes des-

igned, yet fully accomplished. We beheld a few mound springs which had been perforated and their waters made to flow together into a reservoir, instead of overflowing in wastage and despoiling the land. Ah, the engineer had been here, trained in his reasonings from cause to effect, and well weighing the possibilities and probabilities, he had made his computations of these as well as for the needs of the town, and in his own language informed me that "*We appropriated what there was, and developed the rest.*" Yes, *that is it*, "*developed the rest.*" Here was a Horeb in the wilderness, and the people needing water; the engineer was the Moses who smote that Horeb, the waters rushed out, and the people are served with a pure and limped water for their various necessities. So long as those water works shall last will the name of that engineer endure; who conceiving the plan, SUCCESSFULLY "*appropriated what there was and developed the rest.*" We do not claim for these a comparison with any of the works of great magnitude scattered throughout our country, but as a minor work, unpretentious as it is, accomplishing its object as it has from so trifling a source; we simply say, it is grand in its conception, beneficient in its design, comprehensive in its scope, masterly in its execution, and successful by crowning the whole in its completion.

The engineer's duties should not consist only of the performance according to the rule of certain pieces of work under pay, but his whole life should be one of continued careful observation, and of close investigation; to be as sagacious in the various lines of his profession as the Indian, or the hunter and trapper becomes in woods craftiness; besides his skill and dexterity in the manipulation of his instruments of precision, and his ability for the correct solutions of the problems in hand, he needs as a further preparation for his work and usefulness, a thorough training of all his faculties and a constant test of conclusions; to be able by the eye alone to take compartively a perpendicular and also a horozontal line by the erectness of his person to the center of gravity; to be observant of all that is around him, the relative heights and depths, the comparative sizes and distances of objects and their bearings one from the other, angles of ascent and descent, the humidity of the atmosphere, as well as its attended temperature, with its ability for the conveyance of sounds; the volume, penetrability and impenetrability of light in the various conditions of the atmosphere; the high and low stages of all waters in his location, with their periods and velosities; the training of his ear to the location, condition and volume of sound and the causes of augmentation and diminution, as circumstances may reveal; gether in full notes of all deep cuttings and borings relative to the different stratas, their thickness, and the inclination and depth of each, with its direction. In other words, as a summary, let his senses by their training become so acute and under such subordination and control as apparently without effort to reveal to him the state and condition of nature in all her mutations, as well as the state of things in general. These will prove great helps in preliminary investigations and reconnoitering where instruments are not at hand.

But how shall the engineer go about to effect these things? Are not the fields already ripe, ready for the harvest? Let us see. Are the roads bad, low, muddy, almost impassable for periods in the year? Investigate them thoroughly, see what is required to make them good, what different modes of improvement may be adopted with feasibility; look up hills or beds containing gravel, and easily accessible, with which to surface them after proper drainage and turnpiking. Are the well waters impure? Seek first the cause, then, if possible, the cure; or if a supply of better quality cannot be secured by some of the several methods usually employed. Does sickness prevail in neighborhoods, and disease become epidemic? Be sure there is a cause, do not be content with ascribing it to the mysterious hand of providence, but to a neglect of duty, a want of vigilence, a sleeping of the proper sentinels; be sure a foulness is lurking somewhere. Who, better than the engineer, to determine the why and the wherefore of its habitat and the best methods of its removal.

But, as to the manner and the means to effect these improvements, seek every favorable opportunity to post the people up as to the necessity for the needed measures; let no stone be unturned, no vigilence remitted for having them thoroughly imbued with the necessity for the desired work, and the advantages to accrue from the execution; and there will soon be found a leading spirit materializing who will rally the people to your aid, and procure the necessary means, either as a private enterprise or public work, to carry forward the undertaking. The people thoroughly aroused, the work is half accomplished, and needs but little more effort for a successful completion.

As practitioners, engineers should make full notes of their practice, especially where important and novel features and experiences are encountered, and points of difficulty are successfully overcome. The engineer in extending the work of his profession, not only enlarges the sphere of human knowledge, but adds to the conveniences and contributes to releiving the wants of the entire world. If astronomy be conceeded to be the sublime science, that of engineering must be acknowledged to be the most beneficent; it contributes more to the good of man than all other sciences combined, for the measurement of the value of a science is its volume of blessings despensed to man, and as the art of living is the art of arts, so is engineering the science of sciences, because it is rendering the art of living more easily obtainable throughout the entire relms of the earth.

In addition to the data and rules of his philosophy he should add to it the habit of philosophizing, sitting in judgment as to the best mode of adapting the means to the required end. In this manner he will pass from the drudgery of acquiring and using formulas to a knowledge of the principles which underlie them, and become in a great measure competent to lean upon his own resourses for happy results in many undertakings; not forgetting to "appreciate what there is and to develop the rest."

To the close application of the student, he should add the industry of an energetic practitioner. These qualities often pass unquestioned for the gifts of genius, but they will put genius in the rear in the race on life's course, unless it travels in a similar harness. The engineer is not only required to determine the effects from given causes and to produce them at minimum prices, but also from existing effects to be able to trace out causes and to provide suitable remedies for their speedy removal in the least objectionable and costly manner.

It has passed, not only as a proverb, but as an axiom, that the world is entitled to the full exercise of the best talents and exertions of every individual, and all men are morally bound to render them. In this view, if every engineer in this State in the course of the coming year would, to the full extent of his ability, with the chances which are about him, determine to improve his immediate surroundings, by "appropriating what there is and developing the rest," that may be possible, think you not that Michigan would leap upward, as it were, in internal improvements, making a new era in engeneering pursuits, opening up new fields not thought of before, introducing new problems for solutions, rich in results, awakening the energies of the thoughtful and enterprising, bringing to bear talents hitherto slumbering for want of the talismanic touch upon the springs of earnest action in the fields of desuetude, in which their hitherto uneventful lives have reposed.

How much to the length of life, to the consummation of its exertions and energies, and to its value in every recognizable sense will be added, the future only can reveal; but it is safe to say, that if the engineers were fully on the alert and up to their full privilege and duty, working in unison with those interested, should prompt them to legitimate and worthy undertakings that not only would the stride of improvement in the works of engineering, and other business and trades consequently depending thereon, advance in arithmetrical, but obtain even to geometrical proportions.

If the curtain that veils the future were lifted and the door set ajar which seals up its vaults, and a glimpse were afforded of its mysteries and offerings for the discoveries and acquisitions there held in store, awaiting to greet the formost van of investigators, with what alacrity would all haste to the front to peer into those portals and catch a glance of that precious store house ladened to overflowing with blessings to the race; how animated the struggle for loftier planes and closer positions where fuller views could be obtained and resulting knowledge procured. But the debrias that now obstructs must be cleared away by patient endeavors; the stones must be rolled from the path by concert of action, and the line of vision and entrance to the unfolding be detected by the closest scrutiny and untiring vigilance Yes, the price of victory is eternal vigilence.

As yet our views are tied too much to the past, our movement too prone to the incumbency of yesterday; we hesitate to step into fields

where none have trod before; we are timid in venturing where the way has not been pointed out. Who will have the ability to rise sufficiently to seize the cord that may lift the curtain, or to lay hold of the string to raise the latch that the door may open for the mind to grasp and the eye to gaze upon the things which lie upon the threshold of the as yet unknown.

In preparation for the events to come, let us haste to the work, and not be tardy in "appropriating what there is," nor slothful in "developing the rest" which may be required, for the march will be onward, let us not be found wanting.

The remainder of the forenoon was spent in a visit to the plaster quarries, the soldier's home, street improvements, and to the residence of Capt. Coffinberry.

EVENING SESSION.

The following paper by E. Treadwell was read:

STANDARD BRIDGES.

In looking over the noteworthy events of the past year, one of the most interest to bridge engineers was the meeting at Pittsburg in March last of the manufacturers of iron bridges, which was called for the purpose of adopting more uniform and standard specifications in iron bridges. That something of this kind is very much needed at the present time and is soon to become a necessity, is quite apparent to most engineers.

The proceedings of that meeting were of peculiar interest. First, because it was the first meeting of the kind of any importance ever called. Second, from the fact that it was composed almost exclusively of manufacturers, and, Third, from the fact that the proceedings show that manufacturers themselves, after much careful study and discussion are far from being of an opinion as to just what should be put upon paper as "*standard specifications.*" Such as were adopted, would, of course, be expected to be in their interest, and if any are not so, we may ask, "Who is to blame?" It is not the purpose of this paper to criticise their work, nor to say that as a whole the specifications are not as good as expected, It is fair to say of them that we have many iron bridges in this state, which, had they been honestly erected under such specifications, would be far better than they are, and that should they come in general use would improve some of the past practice, but on comparing them with those of Theodore Cooper, Jos. M. Wilson or others that have been extensively used; one not an expert, would wish to make many changes and additions before using them to build any important structure.

It is more the purpose of this paper to look into the buyer's side of the bridge question, and only refer to these specifications as they affect the buyer's side.

An old saying is, "It always takes at least two to play a successful game of poker;" and in bridge business there must in all cases be a buyer as well as a seller, who wishes, and sometimes insists, upon a fair deal before putting up his cash against a bridge. In looking over these specifications we find they relate mostly to methods of manufacture and to qualities of the metal which the average buyer knows very little about, and for him to be sure he was getting what was called for would have to make many trips to, or employ an expert to look after the whole work; either of which might prove unsatisfactory as well as inconvenient and expensive. What the buyer wants is practical results, and as little trouble as possible about methods of manufacture or details of construction. He wants good, neat looking, safe and cheap bridges; and how he can induce the manufacturer to make all this without close watching and at a reasonable profit should be his study.

How is it with the gas consumer, or those using water from water works pipes? what they want is good gas, good water, and ready at all times, and if this is served at reasonable rates, he cares little whether the works are made of stone, wood or iron or how large the main pipes are, or if any leaks occur before getting to his meter.

Experience proves that the more articles of one kind, size and quality that can be made, the cheaper they can be placed upon the market, and that staple and standard articles are sure to be kept in stock. No doubt many of the older members here will remember when the country blacksmith made nails to order for the farmers and that he seldom cut two of the same length. Now, excepting bridges, we have standards in nearly every article from a carpet tack to a steamship, and mostly kept in stock ready for delivery or in shape to be put together in quick order. Is there any reason why we should not have standard bridges, and soon? especially of the smaller sizes, from say 30 to 200 ft; and while the manufacturer is looking after standard specifications for material, would it not be well for the buyer to study his side of the question and ask if some points in his favor would not be gained by having standard lengths, roadways, heights, panel lengths, and standard sizes for floor beams, stringers, posts, rods, eye bars and pins; and thus make every piece, as far as possible, interchangeable. The saving of a few hundred pounds of iron is not the importance it was 20 years ago, and the main question is not how long will the new bridge last with the present manner of loading, but how long before it must be made to carry a much heavier load and at a higher speed? Must it then be taken down and built new entire, or can it be made in such a manner as to add to its strength without taking down the old one? How can the bridge be maintained, in the future, with the least annual expense? and who is the party to do this work? These questions are submitted for the buyer's study and for argument by engineers interested in bridge building.

For one point, and as an inducement for the manufacturer to build good bridges without watching or suspicion, I would suggest, that in asking for proposals for building, the buyer ask for an additional proposal from each bidder to maintain his structure for 25 years—and make it optional with the buyer whether he accepts the first alone, or both. This would give every buyer some idea of the difference in expense of keeping up a good bridge and a bad one, while it would also give the manufacturer a fair chance to express his faith in his work; and also might be made too binding for the success of some companies who put up *skin bridges*, or who would do so if they could.

To make the point a little more clear, suppose that instead of the usual specifications, the buyer should advertise for proposals in something like the following form:

Wanted—Proposals for a bridge,—which may be of stone, steel, iron, wood or paper or all combined, provided it fills the following specifications and conditions: Clear span, 200 ft; clear headroom 20 ft; clear roadway 14 ft; straight center line; level grade; distance top tie to high-water mark 8 ft; clear space wanted above highwater line 4 ft.

In addition to its own weight it must be able and warranted to carry in perfect safety a rolling load of 3500 lbs per lineal foot moving at a speed of 50 miles per hour, with a total deflection under such load of not to exceed $2\frac{1}{4}$ inches. All proposals in addition to giving first cost of structure must contain a second proposal to maintain the structure for 25 years, and it is understood to be optional with the buyer to accept the first alone or both; and the second proposal shall cover the following points:

First—If the bridge blows down it shall be replaced at the builders expense.

Second—It shall be kept in a safe and passable condition for all regular trains at all times.

Third—And for any failure due directly to fault of the bridge, the builder shall be responsible to the buyer for all damages done thereby, up to but not to exceed the first cost of the bridge, beside an additional penalty of $100 for every 24 hours that the bridge remains impassable.

These would be quite unlike the "Pittsburg specifications," and would leave the manufacturer free to use his own standards or adopt others as he thought best, and would give him all the freedom he could ask in the arrangement of his details or in the quality of metal and workmanship; and in the end, I think, prove a steppingstone toward standard sizes, better and cheaper bridges.

The following paper by H. G. Rothwell was presented but not read for want of time.

THE CITY SURVEYOR—HIS USES AND ABUSES.

There can be but little doubt that it is absolutely necessary for the city surveyor of the present day to be a complete civil engineer of great knowledge and varied experience, for he may at any moment be called upon to advise or serve his corporation in any of the following capacities in addition to the multifarious ordinary duties devolving upon him as surveyor.

First—As land surveyor to make surveys of any size that may be required.

Second—As engineer for sewerage and sewerage works.

Third—As engineer for water and gas works.

Fourth—As engineer for the construction and maintenance of roads, streets and bridges.

Fifth—As engineer for the construction and maintenance of lines of tramways, street railroads, etc.

Sixth—As engineers for canals, docks, harbor and river improvements or for the protection of coast and river banks from encroachments and for the prevention of floods.

Seventh—As landscape gardener for the laying out of public recreation grounds, parks and cemeteries.

Eighth—As accountant to examine and rectify workmen's pay rolls, tradesmen's accounts for work done or goods supplied.

The city surveyor, according to his opportunities, has done the country good service, but surrounded as we have been, (and still are) with obstructions and difficulties, cramped and restrained by popular prejudices and private interests, subject to clamor and attack, without protection and without appeal, it is indeed surprising that we have accomplished so much. Were such an officer judiciously selected, adequately remunerated, properly supported and duly protected, our influence upon sanitary progress would be more conspicuous and our office better appreciated.

Pure air, pure water, properly constructed houses and an unpolluted soil are the cardinal conditions of health. These are mere sanitary axioms. The means by which such conditions are attained are drainage, ventilation, water supply, and other matters entirely within the functions of the engineer.

SURVEYS.

Surveys for village and town plats have been (and in some instances still are) made in a loose and slovenly manner. The corners of original surveys have been either imperfectly or carelessly noted and marked or maintained. Street intersections and boundary lines also imperfectly marked or monumented. Measurements taken with chains and tapes (seldom the latter) of various lengths, and careless measurements. Angles often turned and courses run by magnetic needles and common

surveyor's compass, closing fractions not noted and block lines not at right angles. These are some of the many marks of carelessness and slovenly surveying the competent surveyor often meets with and, when the village or farm grows to one of importance, and property becomes valuable, often causes expensive and harassing lawsuits.

Surveyors often assume to straighten these surveys but doing so without proper legislation or consent of poperty owners is highly dangerous.

In citation and for the information of surveyors on these points I refer to 449 Mich., p 94:

"When the accuracy of the starting points taken for test surveys are mainly speculative, they cannot be used to fix a disputed boundary between two lots when the dispute arises from a discrepency which affects all the lots in the block, and which must therefore be apportioned among them.

46 Mich. p 605: When both parties to a suit respecting lands trace title through conveyances made with reference to a recorded plat, it is immaterial that the plat was never properly acknowledged. When in platting a village it turns out that by mistake the blocks are not so long as the plat represents, the deficiency must be apportioned between the lots of the block according to their apparent size as shown by the map, and this rule will be applied notwithstanding the explanations upon the plat, state that all lots are of full size except those made fractional by a named street; it appearing that according to the plat such street made certain lots fractional and such last mentioned lots evidently being all the explanations intended to except.

42 Mich. p 609: The title to property claimed under a recorded plat cannot be unsettled by the testimony of a surveyor who had scaled the plat, that the scale was incorrect. When streets have been opened, used and acquiesced in by the parties interested or by the public authorities, they become permanent boundaries and form new starting points for later surveys.

In Michigan the proprietor of lands bordering on a meander stream owns to the center of the stream, and in platting his lands may extend his plat to the channel bank.

Evidence that the owner of land had intended in platting it that streets laid out by some other plan to which his own was an addition, should it sometime be extended, and had laid out certain lots with reference to such streets, and that the streets had been extended, is admissable in an action of ejectment, as bearing upon the true location of the lands described in the declaration.

The location of lands claimed in ejectment is a question of fact for the jury, and may be proved by any kind of evidence that would be admissable to prove any fact.

40 Mich. p 236: When parties claiming under the same grantor recognize a boundary between them, and one of them afterwards conveys

with reference to that boundary and without encroaching upon any rights existing in third parties, he and those who claim under him are bound by the description as against his grantee, and a change of the recognized boundary by a re-survey will not affect the grantor's rights.

49 Mich. p 59: When the line between quarter sections of land has gone unquestioned for a long time—as in this case, 23 years—it ought not to be disturbed upon a mere disagreement between surveyors, especially if the latter survey is made under circumstances unfavorable to accuracy, such as the absence of corner posts and witness trees and the existance of a boundary dispute.

45 Mich. p 22: A re-survey is inadmissable in evidence to show that a private boundary is incorrect, if its starting point is outside of, and does not belong to the immediate plan or local system by which the original survey was controlled. A division line established by mutual agreement and acquiescence and constant occupancy for more than 20 years, cannot be changed without writing.

51 Mich. 580: Re-surveys cannot be allowed to unsettle the lines of town lots after the lot owners have established such lines in accordance with the stakes which they have found planted or recognized by authority, and in reliance on which they have purchased."

As shown by these decisions, the surveyor cannot be too careful in collecting his evidence. They also demonstrate that village and town authorities should be more particular to maintain, in a permanent manner, the original plats and additions, keeping a record of same with reference points or witnesses, that in the event of sewering, paving, or other cause, the monument may be accurately replaced. The records to be the property of the city, and not as frequently happens the surveyor. It is also important that this work be done by men of considerable experience as surveyors, in practically dealing with the many discrepancies and the collection of evidences to establish the original survey as near as possible and preserve the integrity of the title.

SEWERAGE.

Every village of 2,500 inhabitants and upwards, should have sewers and a regular laid out sewerage system, and stop as early as possible the pollution of the ground and soil built over and occupied by the dwellings of its inhabitants. This pollution is going on all the time, and the sooner it is checked the easier the danger to health and life can be overcome. Village and town corporations have the general impression that sewerage systems are very costly luxuries, and we must admit, oftentimes by the forming of rings, boodle aldermen, corrupt or inefficient boards of public works, or committees on sewers, also by bad judgment in regard to the proper system to employ and incompetency of the engineer, they often prove so, but that such need not be the case can be abundantly proven.

A good system of sewerage should embrace the whole of the following requirements:

First.—Each sewer should be laid at such a depth as will readily drain the basements of the adjoining buildings.

Second.—Its area and gradiant must be so regulated as to make it self-cleansing, and at the same time carry off effectively the maximum quantity of liquid for which it is intended.

Third.—Each sewer should (unless quite impracticable) be laid in straight lines and with even gradients between man or lamp holes, and these gradients must not be excessive, or damage may be caused to the sewer.

Fourth.—Sewers must be laid at proper levels in respect to their intersection with each other, bearing in mind that they are all generally converging to one point.

Fifth.—Manholes should be of simple construction.

Sixth.—Sewers should not be constructed of too large a sectional area, none should be less than six inches internal diameter, nor for pipe to exceed 20 inches. Over this size should be of brick work.

In the construction of a good and efficient sewer system the greatest care is necessary in the materials selected and the manner in which the work is executed. Consequently the knowledge and efficiency of the engineer is of primary importance.

As regards the various systems now used, there are many advantages in each of them and only a careful survey of the locality can determine which of them is the most appropriate to the locality.

WATER SUPPLY.

A good sewerage system cannot be devised without a good system of water supply, and the one is just as necessary as the other, therefore the engineer must give this a full consideration.

ROADS, STREETS AND BRIDGES.

The first and most important part of road construction is thorough drainage. No road or street can be permanently and thoroughly improved without this object is accomplished, yet, strange to say, it is the most neglected in the large majority of our road systems, and when done, it is often in the most crude and imperfect manner, and receives the least, instead of the most attention and skill. Roads and streets that would, were this properly attended to, be capable of being used for the largest traffic even with but slight other improvements, are not available even with the most expensive ones, on account of the neglect of this most important point, and the engineer should give this his first and greatest consideration.

The various systems of metaling or improving the surface of roads and streets are many, and each has its own peculiar advantages which are in a measure controlled by the locality and availability of the material to be procured. In Michigan, we find that wood pavements, (preferably the cedar blocks) is largely used, and with results largely depending upon the manner, quality and thoroughness with which the material has been selected, and the work performed. Macadam, or broken stone roads and, when the material is available, of the proper quality, gravel is used with fair results and answers a good purpose, especially on roads leading from, and through the country, to enable the farmer to bring his produce to the city or village, also on suburban streets where travel is light, but on large business thoroughfares it has proved to be an expensive and doubtful improvement.

Boulnois says the great objection to macadamized roadways are as follows:

First—They manufacture too much mud and dust.

Second—They are too absorbent.

Third—They are very noisy and damaging to vehicles and horses when fresh metaled. (This objection can be got over by a judicious use of the steam road roller.)

Fourth—They constantly require mending, but never seem quite sound.

Fifth—They are frequently encumbered by men and carts engaged in either repairs, cleansing, or watering.

Sixth—They are very expensive to maintain and cleanse.

Seventh—They are bad for a horse to fall upon, as such falls generally damage the knees.

Many large cities have tried them and found them lacking in the main qualties for a good street at all seasons of the year.

Bridges are often required where rivers or canals intersect or abut on town or village sites and are generally let to some bridge company to erect. These companies through close competition and a want of the professional supervision by a competent engineer, often put up bridges much too light to economically carry the loads or to resist the strains to which they are subject, resulting in the bridge giving out and becoming unsafe for public travel, long before the same should occur by the natural wear. The universal practice is to get highway bridges constructed on too low a factor of safety, which is done principally to reduce the first expense, and the penuriousness of corporations to pay for competent professional supervision, to inspect plans and construction.

ABUSES.

In small villages the general rule followed in hiring surveys for municipal work is to take the local surveyor, more for the reason that he is a resident than for his fitness for the work which he may have to do

and generally they can hire him cheaper than a man of large experience in the profession in large towns. The surveyor is either elected or appointed by the board of aldermen. Often he gets this office, more from his political affinities than for his professional qualifications. In large towns and cities where they have boards of public works, he is appointed by them. Were these boards always composed of competent and practical men, whose purpose it was to serve the best interests of the people they were elected to serve, instead of themselves to further their own interests, or carry out some pet scheme, there would be some show for the engineer, but as these things are generally managed, his plans and specifications are so altered and garbled by these august bodies that he hardly recognizes them when they are approved. But if they fail to meet the desired results he is held strictly accountable for them and always if any blame is to be attached he is made the scape-goat both for the board and all other officers who may have had anything to do with the job, although he, as a rule, has nothing to do with their appointment, not being even consulted with in regard to their efficiency to inspect or supervise, neither has he the power to suspend or dismiss them. The great trouble is, that all offices in the gift of municipal corporations are used as rewards to political partizans or liberal contributors to the campaign fund.

Boards of public works, to be effective, should be composed of men that are practical, that know the mechanics of engineering works used for the improvement of cities, and not so much by large property holders who often allow these selfish interests to interpose in the economic administration of public affairs.

The engineer should have more power, his plans and rulings should be respected, and his judgment as regards the kind and quality of work and material used should have more weight than is generally given to it. The remuneration should be ample, as good engineers deserve good pay; in fact he should be the best paid officer in the city's employ, for his work is such that it requires more than average ability to fill the position. He has to keep himself posted in the most improved methods of engineering construction. His books and papers are expensive, his instruments are also very expensive and constantly wearing out. He is never allowed anything for experiments or tests. Corporations would save money if they would spend more money on experiments to test various methods and materials before entering largely upon their use.

But it is impossible for me to enumerate all the abuse the engineering profession gets, and confine my paper within reasonable limits. I have perhaps now trepassed too long on your time and patience.

STANDARD MEASURE.

To the Michigan Engineering Society:

It gives me great pleasure to announce that, through the generosity of our respected Vice-president in presenting the State University with his six feet steel Coast Survey Standard Rod, there is erected at the university a 100 feet standard wooden measure for the benefit of all persons in the state or out of it, if need be. This measure has been erected under my direction and according to Mr. Steele's expressed wish to the Regents of the University when he deposited his six feet steel rod there.

The measure is 103 feet long, of white pine, selected for its even grain, and 2½x4 in section. There are six splices in it, formed to carry every stress that the timber will, as nearly as possible. This 2½x4 in. bar is supported, with the 4 in. dimension vertical, at 18 points six feet apart, center to center, by 1 in. iron bolts with faced heads and nuts passing centrally through the bar, having brass washers screwed to the bar on both sides at every hole. These bolts carry three nuts and clamp suitable wrought iron brackets by means of the two upper nuts. These brackets are of ½x¾ iron and are screwed to a 1⅛ board spiked to a solid brick wall reaching down to the ground. The measure is on the third floor of the main building where the temperature will be very uniform the year around. The brass washers for the two central holes each side of the 50 ft. points—about fit the bolts. All others are slotted a ½ and will allow of any natural movement of the bar lengthwise. Otherwise than this the bar cannot even twist or warp. These simple devices admit of four adjustments at every one of the 18 points of support. The rod stands north and south. At each support it can be set east or west or up or down, thus lining or leveling it.

This simple account will give an idea of the care of this work. There is a shelf below also 103 feet long for long chains or tapes to rest on when being compared. These chains or tapes will be stretched by a pully so as not to throw any stress on the bar, the points of attachment being hooks on the board on the wall.

The marks are not yet put upon the bar, but it is expected that they will be as soon as I am satisfied that the bar is at its final form. Then it will be shellacked and brass plates screwed on its face to receive the marks. Then the marks will be fixed and engraved. This I hope to accomplish during the coming month or six weeks. A little thought will convince anyone that this part of the work is not perfectly simple but I now do not perceive any serious obstacles. Therefore I think that by March 15th, 1887, any one may get a comparison of their measure, up to 100 feet in length--yes—any length in 100 feet sections –with this standard upon the following terms:

1. Express or mail the measure to J. B. Davis, Ann Arbor, Michigan, prepaid—no charges will be paid there. If mailed, send stamp for its return.

2. Send a request designating the want of the sender.
3. Send 25 cents for each comparison required.

In return you will receive the length of your measure for a designated temperature, tension, and sag, with any other especial memoranda that seems necessary.

I find it necessary to make this slight charge to cover incidental expenses. If any sum accumulates therefrom it shall go to keep up or improve the apparatus.

We can now begin to get our measures alike, I think, and when called to court may be able to give in our work in United States Standard Measure.

Respectfully submitted,

J. B. DAVIS.

THE MAINTENANCE OF TRACKS AND THE RAIL SAW.

Gentlemen:

It is not intended to discuss at all the many varieties of track tools for the maintenance of way, but the remarks will be confined to one of the latest appliances, the Portable Steel Rail Saw, perhaps not universal in its application, but which is adopted and of use on most lines of road.

A remark on rail joints is necessary. There are many ingenious devices for upholding the joints of the rails. Without going into the details of any of them, the general statement may be made, that whatever joint is used, continual and heavy traffic generally shows the joints to be the weakest point of the line, and almost universally after long usage the rails show a batter at their ends, and perhaps with the exception of eight inches at either end the rail may pe berfectly sound. Therefore were these ends cut off, these rails might be used again and a smooth track produced.

This is the general use for which the rail saw is adapted. It is unnecessary to mention its use for yard purposes in the construction of crossings, switches, frogs etc., though perhaps in this direction good results might be obtained.

Previous to 1880 nearly all the English steel rails imported by the railroad companies in the United States, had the fish-plate holes punched instead of being drilled. As a consequence the joints are very unreliable, and accidents have occurred attributable to this defect. During the coming working season on the Michigan Central railroad it is understood that the machine which they have will be used in cutting off these punched ends and re-drilling them.

With these preliminary remarks, a few statements as to how the machine is designed and a description of its working may be made.

PORTABLE STEEL RAIL SAW.

The question was asked some three years ago by Mr. J. M.Toucey, for the New York Central & Hudson River railroad, why a portable steel rail saw had not been designed, which would cut off the battered ends of steel rails, re-drill and straighten them, and thus save the expense of transportation on long lines of road to a stationary plant.

At a later date the president of the Michigan Central railroad made inquiries as to a machine that could be used in cutting off the battered ends of some English rails laid on the Canada division of his road. The Industrial Works of Bay City, Michigan, decided to investigate and inspect what had been accomplished in rail sawing machinery by different railroad companies; and finally a design for a Portable Steel Rail Saw was submitted to Mr. J. D. Hawks, chief engineer of the Michigan Central Railroad. The design was approved, and a guarantee was made by the Industrial Works, that the machine would cut 100 rails at both ends, and re-drill and straighten them in ten hours.

The machine was constructed and delivered to the Michigan Central railroad about the first of March, 1886, and has been in operation since, with little breakage or delay, and has thus demonstrated the practicability of the portable plant. About 20 miles of re-cut steel has been re-laid. In one day of ten hours 300 rails have been cut at both ends, re-drilled, and where necessary, straightened.

The problem in the design of this machine was one of *capacity*. For if the necessary speeds, requiring accurate alignment of shafting, gearing and belting, were practicable on a car at all, there should also be such an arrangement of mechanism as to give ease in handling and transferring rails from one operation to another, and cause no interference. Every movement should be through the power of the engine, to accomplish rapidity.

The mechanical arrangement of the machinery is shown in the accompanying plan.

In operation the rail is hoisted at both ends by two cranes and deposited on the feed carriage. The rail is clamped to the carriage, and fed to the saw by the operator on the platform. This operation cuts one end, and to cut the other, the rail is simply run through the rollers of the other carriage until in proper position for cutting the other end. While this operation is being performed another rail is hoisted by the cranes preparatory to cutting its first end.

After both ends are cut, it is run on the skidways to the line of the double-spindle drill, and when drilled at one end, the turntable reverses its position, and the other end is drilled.

If the rail is straight the operation is complete; otherwise it goes to the straightener, and thence onto the ground or on cars.

To operate this mechanism a high speed double cylinder engine with an indicated horse power of 220, is used. Some high speed gearing trans-

mits the power from the engine to a countershaft, to which the pullies of the saw arbre, the double-spindle drill, and the rail straightener are belted. This gearing has a speed at the periphery of 2500 feet per minute. Both gear and pinion are accurately balanced, and the form of the teeth carefully cut. A belt 16 inches wide drives the arbre pully, and has a speed of about 6500 feet per minute. The most successful fusion discs have a speed at the periphery of about 2500 feet per minute, and with this speed, a steel rail weighing 65 pounds per yard, has frequently been cut off in 15 seconds.

Every revolving part of the machine is balanced, otherwise no such speeds could be attained on a car.

The base to which all the mechanism is secured, is a strongly constructed iron car, made of 15 inch I beams and channels. An equal distribution of the weight on the heavier end of the car is accomplished by an equalizer truck, the detail of which is shown.

The feature of portability secured by this machine makes a large saving in the expense of transportation of rails long distances, and it may be used on one division of a road, accomplish its work, and be transferred to another.

For the maintenance of tracks many devices have been used at different times. The shop fixture for patching rails is now condemned. The operation was expensive and unreliable. As an advancement, and which was perhaps the first rail saw used for the maintenance of tracks in the United States, Mr. J. T. Clarke, of the Chicago, Milwaukee & St. Paul railroad adopted and used successfully a peg toothed saw, which required the rails to be heated before the operation of sawing.

Still later with the development in England of the capabilities of the fusion disc, its adaptibility to track work was acknowledged, and several of the largest railroads in the United States have erected a stationary rail sawing mill, using the cold saw. The idea is to erect the plant at some central point on a line of road, and bring the battered ends to this point for cutting.

The portable saw as shown above, from its compactness of parts, its higher speed and more direct application of power to the saw arbre, than is attained in a stationary plant, is cheaper, has accomplished more work than any other of which we have record, and saves long transportation of rails.

MICHIGAN CENTRAL RAILROAD COMPANY.

CHIEF ENGINEER'S OFFICE, DETROIT, MICH.,.....188

J. D. Hawks, Chief Engineer.

RECORD OF RAIL SAW FOR JULY, AUGUST AND SEPTEMBER.

JULY.

1 Holiday.	2 352 ends.	3 230
4 Sunday.	5 264	6 No running.

7	352	16	400	24	352
8	310	17	310	25	Sunday.
9	350	18	Sunday.	26	400
10	400	19	360	27	328
11	Sunday.	20	380	28	384
12	364	21	374	29	510
13	350	22	378	30	382
14	370	23	382	31	370
15	380				

Average, 361 cuts or 180 rails, each working day.
All rails re-drilled and straightened when necessary.

AUGUST.

1	Sunday.	12	420	22	Sunday.
2	300 ends.	13	Not running.	23	420
3	350	14	380	24	434
4	222	15	Sunday.	25	380
5	360	16	306	26	150
6	334	17	444	27	442
7	290	18	404	28	450
8	Sunday.	19	202	29	Sunday.
9	404	20	160	30	390
10	270	21	320	31	446
11	420				

Average, 360 cuts or 180 rails, each working day.
All rails redrilled and straightened when necessary.

SEPTEMBER.

1	412 ends	11	320	21	None.
2	380	12	Sunday.	22	340
3	410	12	470	23	400
4	350	14	550	24	140
5	Sunday.	15	520	25	None.
6	440	16	470	26	Sunday.
7	390	17	480	27	240
8	400	18	420	28	506
9	500	19	Sunday.	29	360
10	420	20	300		

Average, 372 cuts or 186 rails, each working day.
All rails re-drilled and straightened where necessary.

Yours respectfully,

W. L. CLEMENT.

The report of the Special Auditing Committee was received and adopted, as follows:

TREASURER'S REPORT.

Mr. Chairman and Gentlemen of the Michigan Engineering Society:

Your special committee appointed to examine the books of the secretary and treasurer, and prepare a statement of receipts and disbursements for the year, beg leave to report that we have examined into the matter, and submit the following, which, from the incompleteness of the data furnished, we cannot vouch for its entire correctness as to detail:

RECEIPTS.

Cash on hand Jan. 26, 1886	$ 7 24	
Received dues of members	281 00	
Received fees of members	33 00	
Received for advertising	24 50	
Received for reports sold	21 40	
Received for committee on National Civil Public Works.	31 00	
Total		$308 14

EXPENDITURES.

Paid expenses of officers and committee, National Civil Public Works	$ 36 85	
Paid expenses of executive committee	22 25	
Paid postage	36 00	
Paid for printing	27 25	
Paid for stationery	13 47	
Paid for advertising	10 00	
Paid for badges	6 70	
Paid expressage	7 30	
Paid for railroad certificates	2 50	
Total		$162 32
Balance on hand		$235 82

Respectfully submitted,

H. A. COLLAR, Committee.

Resolutions were adopted tendering the thanks of the Society to each and all from whom kind favors had been received, and to the secretary pro tem, M. E. Cooley, and his assistant, H. A. Collar.

The minutes of the meeting were then read and adopted and the convention adjourned.

OBITUARY.

The Secretary has received notice of the death of several members of the Society since the last meeting, accompanying which were the following notices.

PARKER M. BROWN

Was born July 6th 1816, at Bridgewater, Grafton county, N. H., where his early life was spent. His early education was received at Woodman academy. He came to Michigan in 1837, remaining two years and then removing to New York, where he was married in 1841. He lived for a time in Ohio, and afterward in Pennsylvania, returning to Michigan in 1856, where he lived for ten years in the town of Kimball. He had a large experience as Surveyor and Civil Engineer, serving as County Surveyor for 18 years. He also held numerous other offices of trust, and discharged all their duties faithfully and acceptably.

He died at his home in Kimball, September 28th, 1886.

GEORGE FREEMAN.

Mr. Freeman was born at Buffalo, N. Y., and at his death was aged 50 years and 24 days. He spent his boyhood days in Clarence, Erie county, N. Y., where he was married at an early age to Catharine J. Carmer. His first wife only lived about two years after the marriage. Shortly after her death Mr. Freeman immigrated to Michigan, and resided at Goodrich and Millington, Tuscola county, and at Atlas, Genesee county, and at Beaver Lake, Ogemaw county, following the occupation of milling and engineering, running sawmills, tugboats, etc. He owned and operated a mill at Otisville a number of years, from which place he moved to Beaver Lake and was similarly engaged, moving back to Otisville, and from there to Gladwin county. At one time Mr. Freeman was well-to-do, but in the panic of '73, with many others, he "went to the wall."

In 1868 Mr. Freeman joined the Methodist Episcopal church, and for a number of years was an active member, but owing to lack of privileges had not attended services of late years. He was a man of religious inclinations, and in his dealings with his fellow man did unto others as he would that they would do unto him.

Mr. Freeman had been a resident of Tobacco township in Gladwin county upwards of 10 years. During that time he was engaged principally in surveying, and had filled the office of county surveyor from the year 1881 to the first of January last. He also filled the office of supervisor of Billings township from which Tobacco was detached, during the the years 1881 and 1882-3, and was treasurer of the same town in 1883-4. He had also been superintendent of the poor, school assessor, etc. As a public officer his record was never questioned, having proved faithful and conscientious in the discharge of his duties.

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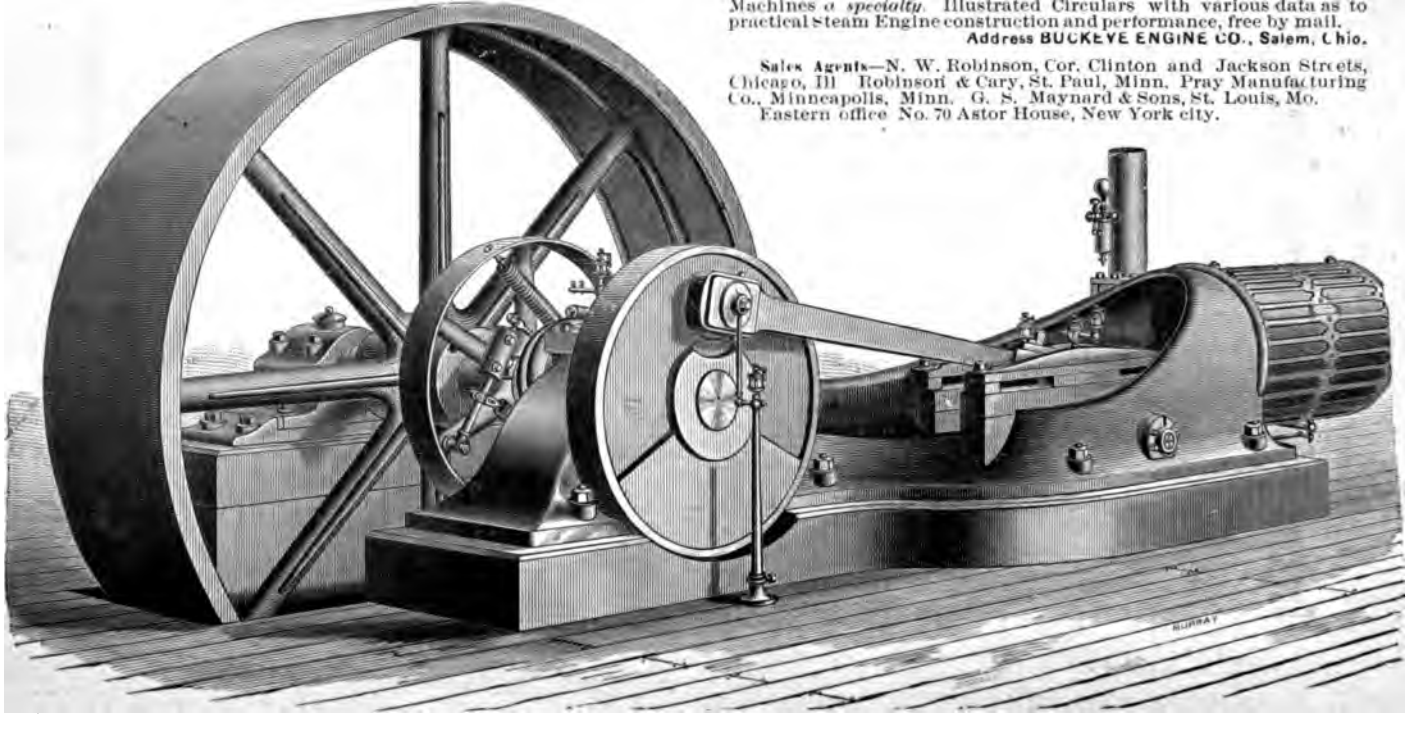

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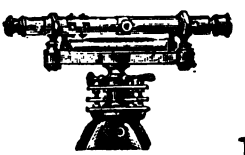

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PROCEEDINGS

—OF THE—

Michigan Engineering Society

ORGANIZED AS MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS, AT LANSING, MARCH 25, 1880.

Re-Organized and Incorporated under the Act No. 232, of the Session Laws of Michigan of 1887, Oct. 12, 1887, and January 19, 1888.

ARTICLES OF ASSOCIATION

The undersigned, seven or more persons of full age, desiring to become incorporated under the provisions of Act No. 232, of the Session Laws of the State of Michigan, for the year 1887, hereby associate themselves under the following articles:

First. The name of said corporation shall be the MICHIGAN ENGINEERING SOCIETY. Said corporation shall have its principal office at Lansing, the capital of said State, provided that the Secretary of said corporation may change its principal office by giving previous notice to the Secretary of State. The period for which it is incorporated is thirty years.

Second. The objects of its organization shall be the mutual benefit and instruction of its members, in the science and art of surveying, and of civil, mechanical and mining engineering, and for the collecting, preserving and publishing of such information pertaining thereto; and the accumulation of such property, books, maps, papers, documents, articles, instruments and machines as tend to illustrate the same, or which may have any historical value in relation therewith.

Third. The officers of said corporation shall be one President, one Vice-President, one Secretary, one Treasurer, and a Board of Directors,

three of whom shall be the President, Secretary and Treasurer. The annual meeting of said corporation shall be held the second Wednesday in October, at Lansing

Fourth. This shall be a State organization.

Fifth. This Society is not formed for mercenary profit and has no capital stock.

Witness our hands and seals, at Lansing, this 13th day of October, A. D. 1887.

GEO. E. STEELE, [L. S.]	WM. APPLETON, [L. S.]
H. C. PEARSONS, [L. S.]	M. H BAILEY, [L. S.]
J. B. DAVIS, [L. S.]	R. C. CARPENTER, [L. S.]
M. E. COOLEY, [L. S.]	L. G. CARPENTER, [L. S.]
JOHN J. WATKINS, [L. S.]	FRANCIS HODGMAN, [L. S.]

CONSTITUTION.

ARTICLE I.—MEMBERS.

SECTION. 1. Any practical Surveyor, Civil, Mining or Mechanical Engineer, in good standing, may become a senior member of this Society.

SEC. 2. Any person engaged or actively interested in engineering pursuits, or whose studies or inventions are especially related to Engineering subjects, may be admitted as a junior member of this Society.

SEC. 3. Honorary members may be admitted to this Society and all of its privileges except to vote.

ARTICLE II.—OFFICERS.

SEC. 1. The officers of this Society shall be senior members, and be elected by ballot at the annual meeting. The nomination of such officers shall be made at the next preceding annual *convention*, by ballot. Their election shall be by letter ballot, which ballots shall be canvassed at the next annual *meeting*.

SEC. 2. In the absence of any officer from a meeting, the Society may appoint *pro tem.*

SEC. 3. A vacancy in any office may be filled by the Board of Directors, until a regular election of officers occurs.

SEC. 4. The several officers shall perform the duties customary to their respective offices, except as may be otherwise specified in the By-Laws; but in the expenditure of money, the Secretary shall draw his order on the Treasurer, and have it countersigned by the President.

SEC. 5. The Board of Directors shall require the Treasurer to give bond in amount satisfactory to them, and with sureties approved by said Board.

SEC. 6. The respective officers shall make reports at the annual meeting of all business done by them for the Society, and shall then de-

liver over all the books, money and property of the Society to their successors.

SEC. 7. The Board of Directors shall arrange the programme of all exercises, and have general charge of the affairs of the Society.

ARTICLE III.—ANNUAL CONVENTION.

SEC. 1. An annual convention of members shall be called by the Secretary, to be held in the month of January, at such day and place as the Board of Directors shall determine. At such convention such matters of business, papers, discussions and exercises shall be presented as will best promote the interests of the Society.

ARTICLE IV.—AMENDMENTS.

SEC. 1. This Constitution may be amended at any annual convention, by a vote of two-thirds of the senior members present; provided, notice of such amendment shall have been filed at the last preceding annual meeting.

BY-LAWS.

1. Members of the former Michigan Engineering Society, on signing the Constitution and By-Laws, and payment of their dues, shall be admitted as senior members of this Society.

2. Any person desiring to become a member of this Society shall make his application, which shall set forth, over his signature, his residence, post-office address, professional experience, the school from which he graduated, or in which he studied; and shall contain a promise that he will, if admitted to membership, abide by the rules and regulations, and endeavor to promote the objects of the Society.

3. The application must be favorably endorsed by at least one member of the Society, from personal knowledge, and be accompanied by the membership fee, which will be returned to the applicant in case of his rejection.

4. Applications for membership shall be delivered to the Secretary, and referred to the Board of Directors, and when favorably reported and classed by them, shall be submitted to the Society for action by letter ballot. Five adverse ballots shall reject.

5. On being elected, the applicant shall sign the Constitution and By-Laws (unless so far removed that the Society may excuse him from signing), and shall pay into the treasury an initiation fee of three dollars, and when admitted as a senior member, the further sum of two dollars, after which payment or payments he shall receive a certificate of membership. If said initiation fee be not paid within thirty days from notice of election said election shall be void.

6. Every person admitted into this Society shall be liable for the payment of his assessments until he shall have signified to the Secretary his desire to withdraw. Any member who shall neglect or refuse to pay any assessment for three months after due notice by mail, shall cease to be a member.

7. A member may be reprimanded for not contributing to the pa-

pers or discussions of the Society, after being officially requested; or for just cause may be expelled from the Society, by a three-fourths vote of those present, but not without due notice to appear for his defense.

8. Applicants for membership, pending their full election, shall be entitled to the privileges of members of their class, except of voting and holding office.

9. There shall be an annual due of two dollars, payable on the first day of the annual convention, and no member of the Society shall be entitled to vote, or to any of the privileges of the Society, while in arrears for dues.

10. Ten members shall constitute a quorum, except in amendments to the Constitution and By-Laws, when twenty shall form a quorum. Three shall be a quorum of the Board of Directors.

11. The By-Laws may be amended at any annual convention, by a vote of two-thirds of those present entitled to vote; provided, notice of such amendment shall have been filed at the last preceding annual meeting.

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PETTEE, T. W.,
Surveyor, Los Angeles, Cal.

PIERSON, GEO. S.,
City Engineer, Kalamazoo, Kalamazoo County

REED, A. L.,
Civil Engineer, Seattle, Washington Ter.

RICE, FRED A.,
Surveyor and Civil Engineer, Alpena, Alpena County

RIPLEY, JOSEPH.
U. S. Asst. Engineer, St. Mary's R. Imp., Detroit, Wayne County

ROGERS, FRANK F.,
Surveyor and Civil Engineer, Marlette, Sanilac County

RUSSEL, WALTER S.,
Supt. Russel Wheel and Foundry Co., Detroit, Wayne County

SANBORN, J. M.,
Surveyor, Gaylord, Otsego County

SEARS, WM. B.,
Ch. Engineer F. & P. M. R'y, East Saginaw, Saginaw County

SHAW, O. S.,
Surveyor, Covert, Van Buren County

SKEELS, DORR,
Surveyor and Civil Engineer, Grand Rapids, Kent County

STEELE, GEO. E.,
Surveyor and Real Estate, Traverse City, Grand Traverse County

STRONG, E.,
Surveyor and Farmer, Kalamazoo, Kalamazoo County

TEED, A. J.,
Surveyor and Civil Engineer, Cadillac, Wexford County

TUTHILL, JOB,
Asst. Engineer D. L. & N. R. R., Ionia, Ionia County

THOMPSON, H. C.,
Civil Engineer, West Bay City, Bay County

TREADWELL, E.,
Civil Engineer, 721 Rialto Bdg., Chicago, Ill.

WATKINS, JOHN J.,
Civil Engineer and Surveyor, Lapeer, Lapeer County

WELLS, GEO. L.,
Asst. Engineer T. A. & N. R. R., Cadillac, Wexford County

WELLS, M. N.,
Asst. Engineer S. Kansas Ry., 632 Kentucky St., Lawrence, Kansas

WISEMAN, JAMES,
Mechanical Engineer, Agricultural College, Ingham County

WHITTEN, WM. M.,
Surveyor and Civil Engineer, 125 N. Lafayette St., South Bend, Ind.

WICKES, H. D.,
Mechanical Engineer, East Saginaw, Saginaw County

WHEELER, E. S.,
Civil Engineer, Sault Ste. Marie, Chippewa County

YOCUM, J. K.,
Surveyor, Chelsea, Washtenaw County

JUNIOR MEMBERS.

CHAPIN, H. L.,
Surveyor, St. Ignace, Mackinac County

O'CONNELL, PATRICK,
City Engineer, Lansing, Ingham County

Michigan Engineering Society.

NINTH ANNUAL CONVENTION HELD AT THE COURT HOUSE IN THE CITY OF KALAMAZOO, JAN. 17, 18, 19, 1888.

ABSTRACT OF REPORT.

The Society met in the court room in the City of Kalamazoo, at 2:30 P. M., January 17, 1888, and was called to order by the President. Remarks were made by the President and Secretary relative to the business of the convention and the incorporation of the new Society. The Secretary's report was then read and referred to the Executive Committee. The report was as follows:

To the officers and members of the Michigan Engineering Society:

Your Secretary would respectfully report the following matters relative to the operations of his office during the past year:

On entering upon the duties of the office, it was found that in consequence of the inability of Mr. Bartholomew to act as Secretary during the previous year, that the matters of the Society were to some extent in confusion. The first thing to claim attention was the delayed report of the proceedings of 1886, which was understood by me to be in the hands of the state printers at Lansing, and promised to be ready in time for the Grand Rapids meeting. I wrote in regard to it, and receiving no satisfactory reply, after waiting a month I went in person to Lansing to see about it. To my astonishment I learned that nothing whatever had been done by the printers on the work. Legislature was in session—the firm crowded with state printing, and Mr. Bartholomew out of town, so I assumed the responsibility of withdrawing the copy from their hands, for the purpose of consolidating it with the 1887 report. After my return home, on examining the package delivered to me by the printers, I discovered that a portion of the copy was missing, and I was obliged to make a second trip to Lansing before I could get it. In the mean time I had made an arrangement with the Kalamazoo Publishing Co. to print 1200

copies of the consolidated report, 200 pages for $317, a greater or less number of pages to be paid for pro rata. They were to be out in May, but the delay in getting the copy together brought the work into the season of the year when my professional duties were most pressing, so that I was able to read proof only once a week, and hurriedly at that; hence the publication was delayed beyond the time originally set for it, and many typographical errors escaped detection which a more careful proof reading would have corrected. With all the delays they were out ahead of those of any of our sister Societies except Illinois, and I held them some time for the receipt of our exchanges so that I might make one job of it and send them all out at once. In July I sent out copies of the Michigan, Illinois, Missouri, Canada and Ohio reports, to all who were entitled to them, and to a number who were not, in hopes that these visible evidences of the active vitality of the society would re-awaken interest among the delinquent members and bring them back into the active membership of the Society. It proved successful and the venture has paid well as the financial report will show. I was able to get only 100 Ohio reports and they were distributed to those members who were not in arrears for dues in alphabetical order as far as they went. Exchanges from Connecticut and Indiana were not received until late in the year and were distributed to the members. I have received from the secretary of the association of Dominion Land Surveyors of Canada a letter looking to a future exchange of reports with that Society. I have also arranged with Prof. Whitham, of the Arkansas Society for an exchange of reports. This is a new Society just started out under very favorable auspices and I look for a valuable report from it. The report is expected to be here next month. That Society proposes to exchange reports even, copy for copy. In the present exchange one copy of our reports counts for two and I get 100 copies of their reports for 50 of ours. The action of the Ohio and Arkansas societies raises a question which it would be well for this society to express an opinion upon for the guidance of the Secretary. Our membership at present is about 50 per cent larger than any of the Societies with whom we exchange reports. Shall we exchange even with societies who will only exchange half or two-thirds as many as we want, to go around, and if so, how shall a just distribution of these reports be made among our members?

Early last year I sent to every person whose name appears in our roll of membership a statement of his account with a request that they call attention to any errors it might contain. A sufficient number responded with their dues to place the Society on a sound financial basis. Some errors were reported and promptly corrected.

In November I sent out the preliminary announcement of this meeting, and early the present month sent out 300 circulars of invitation with program and R. R. certificate for reduced rates. Acting as Treasurer I would submit the following report:

F. HODGMAN IN ACCT. WITH MICH. ENG. SOC.

			Dr.	Cr.
To Cash	Received of	H. A. Collar, General Fund	$ 73 08	$
"	"	" " Nat. Civ. Pub. Wks. Fund	17 00	
"	"	H. D. Bartholomew	146 27	
"	"	Advertisers	171 00	
"	"	Members for dues	196 00	
"	"	" Contribution Nat. P. wks	25 00	
"	"	for reports sold	8 50	
By Cash	Paid for	printing proceedings 1886 and 1887		258 78
"	"	Secretary expenses for getting out same		30 73
"	"	Printing circulars, due bills, programs, etc.		19 85
"	"	Stationery and general postage		26 45
"	"	Exp. charges on exchanges received		20 80
"	"	Drayage, postage and express on reports sent out		51 23
"	"	Prof. J. B. Davis by order of Society		21 00
"	"	Secretary's expenses at meeting of Ex. Com. O. Oct. 12		7 50
"	"	Recording articles of incorporation		1 50
"	"	Advertising meeting of Society Kal. Telegraph		8 25
"	"	Railroad certificates		2 50
"	"	Rubber stamp		1 50
"	"	Bank collections and exchange		1 30
		Cash on hand to balance		185 41
			636 85	636 85

The Society has a note against Henry Strudwick for $25.00 for money loaned him in 1882. As the note was approaching outlawry, and the vote last winter directing the incorporation of the Society called for a radical change in the financial character of the society, I thought it best to have the matter brought to a settlement if possible, previous to this meeting. I accordingly wrote Mr. Strudwick twice in relation to the matter but received no reply. I then wrote Mr. A. L. Wright of Bad Axe, making enquiries in regard to Mr. Strudwick and received a reply to the effect that he was doing a good business, surveying, was able to pay the note and Mr. Wright thought would do so rather than be sued. I accordingly placed the note in Mr. Wright's hands for collection. Some correspondence has passed between us since in regard to the matter. At last advices the note was not paid, but was still in Mr. Wright's hands for collection.

There is also an account of $93.20 for money advanced to pay expenses of Committee on Manual pending adjustment in accordance with the terms of the agreement made two years ago with Prof. Bellows at Ann Arbor.

There is also an account of $10 against Heller & Brightly, of Phila-

delphia, which was reported to me by Prof. Carpenter as unpaid. I have written them three respectful letters, calling attention to the account, none of which have elicited any reply—of any kind. I have drawn on them through the bank and the draft was returned unpaid—and without explanation. In my opinion, a firm who will neither pay their debts nor answer a civil letter in regard to an account which appears against them, are entitled to such free advertising as we can readily give them.

F. HODGMAN, Secretary and Treasurer.

Mr. Appleton moved and it was voted that the Secretary be instructed to send a telegram of greeting and good will to the Surveyors and Engineers of Indiana, in session at Indianapolis. It was so done.

The President called Mr. Appleton to the chair and retired. Communications were read from Messrs. Love, Cook, Guild and Mark. The latter letter was accepted as the report of the Committee on State Boundary, and was as follows:

HILLSDALE, Jan'y 16, 1888.

F. Hodgman, Secretary of the Mich. Engineering Society,

Dear Sir:—I find that I shall be obliged to forego the pleasure and profit of attending the meeting of our Society at Kalamazoo, on the 17th inst. I regret it much and know I shall lose a rare treat for your programme indicates that it is to be one of the most interesting meetings of the Society. That is saying a great deal.

As chairman of "Committee on State Boundary" I have no formal report to make, but can say slight progress has been made. As this is an off year for the meeting of the legislature, of course nothing could be done toward securing legislative action farther than taking some of the preliminary steps. In this direction I may mention personal investigation made along the Michigan and Ohio line, (or where it is supposed to be) but with very unsatisfactory results; inquiries made of the inhabitants living near that line disclosing an entire ignorance of its exact location; correspondence had with other surveyors disclosing a like ignorance on their part with, perhaps, one exception, and interviews had with the supervisors of the border townships in Hillsdale county, in whose minds I discovered already an awakening interest in the matter. They will give the subject their personal attention and aid in collecting information of the land owners along the line as to their knowledge of its location and as to their needs and desires in reference to its being retraced and permanently monumented.

So far as my inquiries have gone, there has been a general expression of the desirability that some action should be taken to secure that object and I think when the proper time arrives the board of supervisors of this county will take such action toward bringing the subject to the attention

of our legislature, as reasonably may be asked of them. Wishing you a successful meeting, I remain respectfully yours,

GEO. A. MARK.

EVENING SESSION.

PRESIDENT STEELE.—"Gentlemen of the Society, please come to order. We are unfortunate in not having a larger attendance of the members of the Society. We have been invited here by the citizens of Kalamazoo. We were told that they wanted us to come—that they had a good place to meet, plenty to eat and a good many things to see; that in reality Kalamazoo was a good place to come to. We have heard a good deal about it and have come at the invitation. Seeing is believing, especially when enforced by the citizens and their representative, Mayor Ranney, whom I have now the pleasure of introducing to you."

MAYOR RANNEY.

Mr. President and Gentlemen of this Convention:

I understand this is the first convention of engineers ever assembled in Kalamazoo. It is not, however, because you would not have been welcome here before, neither is it because we have been so cold in the interests of your profession as to freeze you away. Certainly not the latter reason, for I say it very modestly, as Kalamazoo people always do in speaking of themselves, that we are represented in this convention by one of our own sons whom we are proud of as an engineer, and who has kept engineering matters warm in our midst. He must excuse me for being thus personal, for I know he would shrink from saying himself what others judge of him. But as a science I confess our community is very ignorant in your profession, having all we can do to engineer our own canoes, leaving the scientific part to professionals, but of the more regular professions, however, the ministry, medicine, law and politics, we are experts, but the mysteries of engineering mathematics are not congenial.

We are glad to see you gentlemen, for we are all naturally inclined to wander a little from a bee line and even your presence without the compass will have a healthy influence.

In behalf of our city I would say that it is a pleasure to meet you, as it will be to show you whatever of interest we have, and we trust that you will return to your homes and duties without a regret for having come here.

PRESIDENT STEELE.—*Mr. Mayor and Gentlemen:* Allow me to express in behalf of the members of the Society the thanks which are your due for this invitation. We take it that these assemblings are for our mutual good; that co-operative thought, word, and deed are for the good of all, that we as engineers come here to observe and to learn.

We came here to look over your engineering works, which we hope to do before we go away and comment upon them among ourselves. We want to see what is here exhibited in successful operation. We want to disseminate this information all over the State and we hope these meetings will do us good as a State. We hope also that you will not regret our presence. We bring no great amount of instruments to work with, though there is a fine display as an exhibition. We promise not to cut down your shade trees, to do nobody any harm, not even the hotel men, and to pay our bills when we are done, and now

Members Michigan Engineering Society:

Allow me first of all to open this address with the closing congratulations of last year, that the bright engineering prospects then appearing have been realized all through the year, and it is a matter of just pride throughout our beloved State that she has everywhere made such advancement. The engineers have been too busy to write many letters, and those we have received have uniformally closed with regrets that urgent business and many engagements have prevented the customary salutations and suggestions. The great progress made in railroad building, especially in the Upper Peninsula, has made the engineers' services in good demand, and even now in the deep snow some parties are pushing their lines through the forest, and next year will see many new places opened up. The mechanical engineer has been rushed with work, and the draughtsman and architect have worked late hours platting new villages and planning buildings to be erected in them.

The act of incorporation passed by the last Legislature has enabled the Society to take on a more permanent character, and since its full incorporation has been effected it will be ready to make historical and other collections and assume greater responsibilities and duties. It should be the aim of every one to make the Society of value to himself and others, that an admission to its membership may mean more even than it has done. Such a Society well officered and working with its might can do much in the practical education of the young engineer, to supplement what our schools and colleges may give. We are especially reminded of the need of this when coming in contact with one who has assumed the title of C. E. and yet seems most deficient in every-day things; talks fluently of higher mathematics and calls hemlock, pine; runs in reverse curves simply to show his skill, and drives a hub as a woman drives a nail. We need more of that education which makes itself felt without any titles, which either with or without college honors knows how to sharpen a stake, or make a bench spot; that cannot be fooled into counting basswood for cedar ties, that is not looking for bears hidden in every hollow. Not long since a young man calling himself pretty smart, of the lavender water kind, went out with a party as back

rodman. His mother fearing his arduous duties and camp life would be too much for him, wrote to know if she should not send three pillows. Oh! Dear mother. Let the boy make a pillow of his coat. Let him make his bed on the cold, cold ground covered with boughs; let him work up an appetite that will call for a second piece of sole-leather beef, let him know every time how to adapt himself to circumstances adverse or perverse. He is not educated until he can. Perhaps there is not much comfort in these thoughts for those who are being educated as engineers. We admit it. It is uphill business at first. If you will ask one of our members who is chief engineer of two prominent railroads in this State about his first efforts to learn, he will tell you how he was first an axeman and blistered both of his soft schoolboy hands before he had worked two days, but with commendable courage held on to the job. You will need that grit which will work all day in the rain and not be very perverse at night; that can wade a swamp or climb a hill beset with briars; that calmness which can whistle when a rear flagman holds his rod askew or goes chasing a rabbit; that delectable patience which can sing a hymn while a curious bystander tries his knife on your needle and steps on the tripod foot. You say of course schools and colleges do not give these qualities. The professors—some of them—do not seem to have anticipated them. The colleges may do much towards it, though, and be it said to our honor as a State that we are nearer now in the track to give our engineers a practical and efficient education than ever before. We note with pleasure the tendency to enlarge the field and shop privileges of those studying civil and mechanical engineering. This should not be hampered for want of funds, either at our University or Agricultural College. It is as good a means of education as was ever devised. You may cram a bag with bran and it will only be bran after all. Give us more of the solid wheat. Give us more young men who can forge an eye bolt, file a saw or turn a potato masher, and less of those looking for a soft job behind a counter. The first will rise higher, the latter never. Give us more of that system explained and elaborated in the *Michigan Surveyor's Manuel* which teaches how to survey by surveying, which takes the pupil to the field where he can fight mosquitos and try to read a ten second arc at the same time, where he can break as many cross hairs as he pleases, and put in new ones fresh from the spinnarets of that most original and skillful of engineers, the spider.

We can but renew the suggestion of last year under sections "D" and "E" as to the importance of noting new forms of machines and constructions, and compilation of decisions of courts in land cases. The result would be valuable information in a form accessible to all our members. Let us have some member or a special committee for each of these departments, and keep them at the work. When there are especially valuable improvements made in our instruments, or in machines, note them

and keep our society abreast with all these. When there is any ruling of the Interior Department affecting land surveys, or decision of State or United States Courts in the line of our study, let them be given as fully as may be. This will make our reports of value for reference. It will give our members something new to think about when they meet.

The art of photography has now been so perfected through the use of improved lenses, preventing distortion of any of the parts, that this Society should begin in earnest to collect photographic views of special structures and machines. Even views of structures under way are very useful as studies. The *how* to do it is just as important as the completed work. In this connection we would invite for the Society the donation of such books, maps, drawings, instruments and views as will serve its educational purposes; and if anyone is about to make a will and would sleep any better for a good, liberal legacy to the Michigan Engineering Society, to give it some permanent place and a suitable outfit, we hope they may do so. We can see no reason why this Society may not aspire to have a room or a building at the University, Agricultural College grounds, or our Capitol City, which can be a studio for engineers, an instructive and permanent collection of whatever may pertain to their profession—a profession by which in the elevation of its members the whole State is greatly benefitted. The wise and skillful engineer has much to do for the health and prosperity of the people. The novice and unprogressive fogy may leave a trail of suffering in their paths. Such collections would illustrate many principles, be valuable as references, and in time be of great importance in comparing more recent improvements.

We must commend especially the present programme in that it brings out of the garret of recollection a paper on the "Invention of the Solar Compass," and another of "Reminiscences of John Mullett." Not that we have particular regard for these topics, but they come within those lines of work which should be vigorously undertaken—the historical and biographical About the beginning of last month we met a man of over 80 years, a most genial gentleman, and said to him: "Mr. ——— we want to sit down with you some time with pencil in hand and note down some of your recollections of early Michigan history, and especially of railroad building. You have been acquainted with it all." He was just about to take the train, and spoke of how delighted he would be to go over "Ye olden times" again. It was not many days till his sudden death. We may now have this reminder that time waits not our plans, and consequently cannot urge this work too strongly on every member.

The diversity of our individual experiences and pursuits greatly enlarges the scope of the Society, and will afford in the future a varied programme. It should be our aim to bring out from the stockade all our accoutrements, flint-locks and pop-guns and brush them up! Nobody can tell what a roar they may make if they all go off at once. Our able

machinists and mechanical engineers are only waiting for the smoke to clear away!

The tendency is more and more to grow men one-sided, like a grafted pippin in a knurly crab stock. They develop in one direction—towards their specialty. They finally get so as not to know or care for anything else. This Society can bring various minds together in social intercourse, can bring out the thoughts in some new direction and towards the specialty of some one else, and can infuse a new life into everyone enjoying its meetings. Its social, business, and professional interchanges are therefore helpful. May our meetings be conducted with that respect for one another's opinions, and that considerate regard for the topic discussed whether it be our favorite one or not, that the student may find a place in our midst, and the gray-haired disciple of the transit and rod be once more a boy, but ever a man.

Surely "our lot that has fallen to us in pleasant places." "We have a goodly heritage." It was in 1825 when that educated but determined engineer, George Stephenson, was sitting in the witness box of a committee of Parliament to give his reasons for thinking he could construct the Liverpool & Manchester Railway across Chat Moss—a wet bog—also attain a speed of 10 miles an hour. He dare not say 12, for fear his whole testimony would not be believed. The committee thought the engine would very much frighten horses and cattle with its red-hot smoke-pipe, and when one of them put to the eminent engineer the following: "Suppose now one of these engines to be going at the rate of nine or ten miles an hour, and that a cow were to stray upon the line, and get in the way of the engine, would not that, think you, be a very awkward circumstance?" "Yes," replied the witness with a twinkle in his eye, "very awkward for the coo."

There is enough stupidity in men of high position in our day, but it develops on other things than the running of slow coaches and difficult railroad constructions. Many of the questions which were disputed 50 years ago have been settled, and we are living now in the realm of demonstrated facts. We ride 60 miles an hour and ask what next? We swing a bridge over the tall ship's mast, and say give us something that is difficult. We talk to our friends hundreds of miles away, and long for a bigger world to conquer.

These are marvelous days! May each take his active part in them, as they pass, and rejoice with your President that we have the privilege."

PRESIDENT STEELE.—"We are to have a paper this evening from Mr. Appleton on "Stray Thoughts of an Engineer in Cross Section and Profile." Mr. Appleton, are you ready for it?"

MR. APPLETON.—"I am."

Stray Thoughts of an Engineer in Cross Section and Profile.

Mr. President and Members of the Michigan Engineering Society:

As I have been honored with an invitation to write something that has occurred to me, in my practice as a City Engineer, and present at this meeting, I ask your indulgence for a few minutes talk on this much discussed subject. I shall keep as clear as possible from the rich and necessary fountain of knowledge, common to us all, viz: standard books. It is, perhaps, necessary to say the duties of City Engineer are varied, onerous, and difficult to perform well, and quite impossible to give satisfaction to all the public, especially the critics, who talk about what they know nothing about, as neither facts, theory, or experience, stand in the way to obstruct their flow of eloquence. All this, however, must be ignored quite courteously, and a studious, careful and intelligent, yet self-reliant line of action followed, in the conscientious construction of sewers, laying street pavement, sidewalks, building bridges, ornamentation of cemeteries or other grounds, any and everything the Engineer is expected to do, and do well, though pinched by a false economy, a lack of suitable materials, a factious interference from the narrow partisan and the small politician, each one ready to add their full share to the contractor's and other species of annoyance; in any event he will be held responsible for any kind of defect or failure. I am not suffering just now from any of these, nor am I bitter or sour. I state it as I know it to be a fact. But as sewering, sanitation, bridge-building, and all the expensive and showy improvements have been treated of so fully, and so much better than I can hope to do, and as I wish not to plagiarize, so will let them entirely alone, and at the risk of appearing simple, will ask you to bear with me, and turn your attention for a moment to the cheap construction of good, passable roads, sightly residence streets, and their twin accompanying necessity, cheap, durable sidewalks; these hitherto too much neglected adjuncts to every city or village, which form everywhere nearly ninety per cent. of the entire road in new cities, and all the road they have in country places. Too poor to pave, we must do something very cheap or remain in the mud, and the only thing yet found feasible is gravel; taking for granted the street or road is graded, or at least means provided for good drainage, and a proper width of street decided on. This in my experience is about thirty-three feet between gutters, the remainder being sidewalk and lawn. This is all the roadway ever needed, and the remainder is better left for ornamentation by the lot

owner, for if left in a worse than useless wide roadway, it becomes a wilderness of noxious weeds and an unsightly nuisance. Inhabitants soon learn to beautify these side lawns.

In graveling, it is the common practice to put on the whole amount at one job, from eight to twelve inches thick, and about ten feet wide, and it is done. The effect of this method is, the spots where the loads are dumped are more solid than between the loads, the tendency being to make hills and holes like the waves of the sea. The travel also avoids the new gravel and takes the gutter, until by the passing of teams and the settling of the new gravel, the stream of travel gets near the middle of the road. Before this is accomplished, by the uneven gravel, and the breaking and rutting of the sides of the street, the job is ruined, being like a net, either holes or knots. This remains until another general fix-up, when the operation is repeated. A better way is to put about five inches of gravel first time. Teams are not so shy of it, and it soon gets packed. The bad places will soon show. Now add a second and third coat of the gravel at intervals of twenty to forty days, as best suits the circumstances of the case, carefully spreading and forming a crown to the street. The better results far outweigh the trifle of extra labor of spreading, which is all the extra cost about this plan over the other. The difference of soils on which gravel is placed, the quality of the gravel used and many other things enter largely into the success of this kind of road making. Neither mealy sand or stiff clay is a bar to good gravel roads, only the materials must be differently proportioned. The best gravel road I know of is in Mt. Hope Cemetery, Lansing. This has stood hard and smooth for ten years and was formerly soft, mealy sand. I have seen carriages stalled though well horsed, where now the same team would draw a three ton monument very nicely. Nothing was used to make this change but clay and loose, sandy gravel. It is fair to say these were not thrown together hap-hazard, but exactly proportioned and closely superintended, amid adverse criticism, by its projector. The cheapness and durability of this successful little piece of work, sealed the mouths of critics who had said a plank road was the only remedy. There are very few places where good road material is not found in abundance if patiently and persistently looked for.

As this is not a treatise on highway improvement, but stray thoughts and considerable experience thrown out at random, we will drop the subject, and, hoping not to be tedious, I want to say something about sidewalks. The growing scarcity of lumber and its questionable value for the purpose, has made some cheap substitute a necessity. Most of the damages cities are called to pay are for defective sidewalks—and this generally means a broken plank. Concretes, as they are called, have been adopted in some places. As my paper is applicable to new towns only, the first requisite is cheapness, coupled with all the durability to be had for the money. The most sightly of the several mixtures is perhaps

cement and gravel, but this artificial stone is too costly to fill the bill. It is liable to crack and disintegrate and is also a slippery pavement. Next comes the coal tar mixtures. Some of these are utterly worthless while others make good desirable footwalks, and if proper care is taken are well adapted for crosswalks, being hard and serviceable. The worst features of this kind of walk seem to be in getting it uniform. A piece of walk will be put down and seem nearly perfect, while a piece adjoining put down the same day, and by the same men, will crumble very soon, and by the second year have a scabby appearance. This seems true of all the tar walks. I have seen some of the Staples walk very good, and some very poor. I think perhaps the kind that is put on hot is as satisfactory as any, if well handled, on account of its many good qualities. I have taken great pains to learn the cause of the occasional, and quite too frequent failures, and I believe they are largely due to want of care in heating the mixture, and as it is possible some are not familiar with the operation, I will state it as briefly as I can, although a patent is claimed for it. Here are the essentials: A bed is prepared by excavation, and removal of the surface soil eight or more inches in depth, according to the kind of sub-soil, and the trench thus made filled with good, clean sand. well rammed or rolled; and if for a street crossing, a layer of cobble stones on top of the sand, making a kind of rough pavement, this to be rammed and packed smooth, to the desired form and grade that it may not settle unevenly. On this foundation not less than four inches of concrete is put as follows: Screen good, sharp, sandy gravel; put the coarse part into a large, suitable pan, make hot and dry; now put proper proportions of tar and pitch in the gravel, stir briskly 'til well mixed, put on hot as much as will make three or more inches thick after being well rolled; then take the fine screenings, treat similarly, and lay on 'til there shall be at least one inch of the fine concrete, after being very thoroughly rolled. Now the patent would put on a wash of some chemicals with a brush. During the last summer a plan has been devised for putting cement on the last coat and rolling it in. This is too recent to judge of its value, but it certainly adds to the good appearance. Cheap as this concrete really is, it is in danger of being cheapened too much, and a poor walk must be the result. Now for the cause of the defective spots. In heating this mixture if it is not kept moving, or, as frequently happens, a portion of the last in the pan is raked on one side, and the attendant leaves it to refill with sand for a new batch, this neglect of the residue allows the tar to burn, and of course destroys its value; this burned stuff crumbles right away as deep as the first coat and the walk is spoiled. You still have, however, the foundation. There is one good thing about these walks, which should not be lost sight of, even if crumbling does take place, the loss is not large and there is no danger to life or limb. Cracks are either the result of bad foundation or a tree root is making itself a nuisance. There is not much trouble except from

crumbling. In penning these few thoughts that have occurred to me in my experience with roads and walks, I have confined myself to the cheap class, that must be made, if made at all, without the road roller, which, if possible, should by all means be used. If the funds could be forthcoming, a better system should be adopted.

Hoping the few minutes I have trespassed on your time may not be lost to all, I thank you for your attention. I would like to say why I don't like block and cobble stone pavement, but most of you have experienced a real grief to see blocks so soon worn and rotten, and the cobble so rough, and the streets eternally up for repairs. Won't some one invent a good, cheap, and durable pavement, not too slippery, or introduce for general use some of the preserving processes for blocks. But much time has already been given to what will not interest all. Nothing said about sidewalks has any reference to the costly, well put down asphalt walks of Europe, though our tar compares well with those first put down there. I have seen them very scabby and bad.

Since closing the above I have been urged to say a word about sewers and their construction by day's work versus contract. Keep cool, I won't bore you long, I am as tired as you. I have had a good sewer experience and if my testimony is considered worth asking for, I am willing to give it, only I don't know what part will most interest a mixed assembly. But if the divided system is under discussion, and it is intended to teach people they may connect cellars with storm drains with impunity, I should say, don't. Be as careful in connecting with a storm drain as you would with a sewer. Trap and ventilate, especially ventilate. It costs but little and it is the sheet anchor of safety, as a protection against sewer gas. I have found a good way to ventilate is to take the fire-clay hand-hole trap, and change the ends by placing the socket next the public sewer. This brings the hand-hole on the sewer end of the trap, which can be used as a ventilating shaft, using fire-clay pipe to the ground surface, then put one drain tile mostly out of the ground; fit a sleeve of galvanized pipe, which must be carried to such a distance upon and by the side of the house that the scent will not be a nuisance. This allows the removal of the sleeve, and with a swab on the end of a rod, the trap can be cleaned by working the swab as a dasher in a churn without disturbing the ground. This has worked so well that I thought to get some of the traps made with the socket reversed, so as to avoid the inconvenience of having the sockets come together, making an awkward joint. Of course the ventilation should be between the trap and the sewer, and not between the trap and the house. There is no need of complicated arrangements, the simpler the better. An arrangement by which a swab and pails of water will thoroughly flush a trap is desirable.

Now, about the mode of building. Why do we construct sewers? Is it to promote health, comfort, and convenience among our citizens, or for

the benefit of those who build them? I know cases where the contract awarded the contractor a sum one-third larger for lumber left in a sewer trench than the original cost of the lumber. This would indicate that it was for the benefit of the builder, for it was creating a market at a good profit. I never left any lumber over a sewer yet; it is unnecessary. Now, if sewers are built to supply a necessary want of an already tax-burthened people, then they should have this great luxury at the very lowest possible cost compatible with a first-class, well ventilated, and durable piece of work, and I know of no way of furnishing all these at cost, except by honest, well-put-in days' works and good material at market price. I am fully aware that this like anything and everything may be abused; but is not the other plan also liable to great abuse? Sewer construction, unlike many other things, seldom shows its defects at once, in fact, there are few kinds of work where the chance to slight the job and do poor work is so good. the work is covered up at once, and after, inspection is impossible. I have found a Superintendent is unsatisfactory. Just think, as soon as a contract is made, a conflict of interest is at once inaugurated. The city wants a good sewer; the contractor finds it to his interest to do as little as he can. get his estimate and final settlement, pocket his money and go on his way rejoicing. If the sewer fails, all are agreed there is something wrong, but the sewer fund foots the bill of taking up. Beside the fact that sharp contractors are generally ready with their little bills for extras. Somehow or other these little extras are generally in to fight over, as the contractor has everything to gain and nothing to lose. Is there an engineer on earth that has not been pestered like this, "Raise me a little out of this quick sand," or this, "Ain't you got me too deep?" Gentlemen, there is a conflict hostile to the best interests of the people, for whose convenience the sewer is supposed to be made.

On the other side there may be loitering or trifling of time. I have constructed a great length of sewers by days' work, and I am proud to say, there is not a foot of all these several systems that is not doing all that was ever expected of it, and I never was troubled with poor labor but a short time. Why should we? The men are sure of their pay, which is not always true of the other way. I think that the cheapest and best way is, that the responsible person, planning the system, and whose reputation is at stake, should have the fullest control at every stage of the work as it progresses. But while I am quite sure this is the best way for the good of the public, I am not so sure it is the best for the engineer. Human nature steps in here and demands attention. If you do good work, the best citizens and tax-payers will appreciate your efforts, and be your friends, but the unselfish and patriotic contractors, and their friends will gather in groups, assisted by the tradesmen who furnish the contractor's men with goods, on the bosses' orders, at a shave of 10 or 15 per cent. These men will find listeners to sound

arguments, that it is better to pay 25 to 50 per cent. above cost for the good of a go-between. In these discussions Mr. Engineer is not likely to be flattered. There is another element, too; the city councilman is very likely to have an axe to grind, and the contractor may be a good man to turn grindstone. Votes count, but on the whole, perhaps, as engineers, if we keep our eyes single, always endeavoring to do our duty as public servants, we shall have a good conscience and never lack friends.

PROF. M. E. COOLEY.—"Can the gentleman from Lansing tell us why it is that in Ann Arbor dodgers pasted on the cement walks are the cause of peeling up the upper layer of the walk? It seems to me a very strange thing and I have not heard it explained satisfactorily."

MR. APPLETON.—"I think it probable that the upper layer must have been too thin. The first of these walks were nothing but tar and gravel mixed together and it was ever and eternally till they set, and then they did not. There have been a good many methods of making these walks that were not good for much. Latterly they have been made by putting in a portion of pitch with the tar to harden it. When properly laid on a good foundation, this makes an excellent walk. We have put down a good many miles of this walk and I do not know of one that has failed, but then I find some places which come up as you talk about. When it is very cold weather they are liable to put in a little too much tar. If it is hot weather they may put in a liitle too much pitch. When a man is putting down a walk he wants it as fast as he can get it. It is put down for from five and one-half to six cents per foot. I don't know what it could be that you speak of. I cannot imagine what effect a little bit of paste would have."

MR. PEARSONS.—"What is the relative cost of this walk compared with wood?"

MR. APPLETON.—"Plank walk, costs about $4.50 per rod. This costs about a dollar more. Of course this will vary a great deal. If you find any defect in the walk you will generally find it in the foundation."

MR. PEARSONS.—"Now in regard to the relative endurance?"

MR. APPLETON.—"I cannot see any end to it. When it gets worn all you have to do is put on a new covering. Before putting on a top dressing clean it off and brush off the loose dirt; then put on a thin coat and finish with a roller. Do not roll it too soon or too much. If too soon it will stick to the roller."

PRES. STEELE.—"Prof. Cooley seems to have trouble because in Ann Arbor the boys paste dodgers on the sidewalks, and it breaks the stone or the cement. Now I do not know how it is in Ann Arbor, but in some cities the character of the advertising is such that I should think it

would break even a solid stone walk. In Ann Arbor I suppose it could not be explained in that way."

PROF. COOLEY.—"I think that the paste on the walk acts like glue in a teacup. When it cools and shrinks it will have the effect to pull the porcelain lining off the cup. There may be force enough in the paste, under the action of the sun, to have the same effect."

MR. APPLETON.—"These walks are laid with four or five inches of coarse gravel and after that has been rolled three or four times its top is brushed over with tar and sand. It is this top coating which pulls off. It is certainly a great improvement and is being improved every year."

PRESIDENT STEELE.—"We will now proceed with the business of the evening. Are there any committees ready to report?"

THE SECRETARY.—"I think the Committee on Land-Laws and Decisions has its report ready. Mr. Appleton is chairman."

PRESIDENT STEELE.—"We will hear the

Report of the Committee on Land Laws and Decisions.

MR. APPLETON.—

Mr. President and Gentlemen of the Convention:

I will report as a member of the Committee on Land Decisions, that Mr. Hodgman, our Secretary, has promised me to give a list of decisions and as I know he is well posted on that subject, will call on him to give us the benefit of his research and will only take time to read a few extracts from the address of Mr. Babb, L. L. B., found on page 22 of the report of the meeting of the Missouri Association, held in June, 1884, and as I suppose all are familiar with Judge Cooley's address, I will not take time to read his fatherly advice; but it is worth our while to consider, when we know so much how little we have learned about the law governing boundary lines. I will just read and give way for Mr. Hodgman.

Mr. Babb says: "I approach my subject by stating that if the true boundary line is fixed and can be identified, a verbal agreement by which a different line is established is void, because it is virtually a parol transfer of the land included between the true line and the one so established. The law cannot recognize such a transaction, because it contravenes the statute of frauds which requires all contracts made in relation to real estate to be in writing.

"But where there is a doubt of the identity of dividing lines, where they are confused, or their location is in dispute, the owners of contiguous lands may fix and establish their lines by parol agreement.

"It may be well to here note the distinction between the two cases. If the lines are known, there is, as before stated, a direct attempt to

convey real estate without observing the forms required by law; but where the line is uncertain, neither party acquires title by the agreement. If, in a subsequent dispute between the parties the agreement is admitted, the law does not consider the question of title but simply precludes either party from claiming or proving the true line to be different from the one agreed upon.

"The principle which thus fixes the rights of the contracting parties is known to lawyers as the doctrine of estoppel, and for the purpose of this discussion may be defined as, 'an intelligent, voluntary admission, or declaration, which the law does not permit him who has made it to deny or disprove, for his own benefit and to the injury of another.'

"It is held that this principle cannot be invoked to sustain an agreement by which a boundary line is established unless the following conditions are found to have existed at the time:

"First: The agreement must have been entered into between persons who had title to the premises divided by the line, for it is not consistent with common sense that a contract should be binding when one of the parties thereto wholly lacks the right to contract. Hence, an agreement made with regard to a boundary by a person while he is an occupant without title cannot be binding upon him after he acquires the fee; nor can any conduct of his be so construed as to affect a subsequently acquired title. In other words no one can relinquish title by estoppel who could not pass it by deed.

"Second: The party attempting to set up estoppel must have acted on the agreement with the acquiescence of the other party, and it must be an injury to him to allow the correctness of the line agreed upon to be disproved; and in this State, when owners of contiguous lands thus mutually establish a division line and use up to it, and occupy according to it for a period sufficiently long to show their acquiescence, though less than the period of statutory bar, they, and those in privity with them, will afterward be estopped from claiming a different boundary. And it is further held that, though the agreement as to actual location may not be express, yet if one party assumes to locate the line and the adjoining proprietor has acquiesced and acted according to it, there may be an estoppel, if it would work a practical fraud on the party claiming the benefit of the estoppel to allow the other to disturb a location made and acquiesced in by himself.

"Without attempting to show the application of this doctrine to a numerous class of cases of great importance to lawyers, I pass to the consideration of a condition which is more pertinent to this discussion and the rights of parties to controversies in which County Surveyors participate.

"Third: To make the agreement binding, it is necessary that the parties thereto have a knowledge of the essential facts. For if, in making a contract, one uses his superior knowledge to mislead another, or if one

or both parties act through ignorance, or a misapprehension of their legal rights, it would be within the special province of equity to give relief from ensuing hardship or injury, even though such contract might be legally binding, much less would equity excuse its special function to work a hardship by creating an obligation which could not exist in law. Hence, in this State if adjoining proprietors, by mutual consent, use and occupy, for any period of time, up to a dividing line erroneously believing it to be the true line; or if by mutual agreement, an attempt resulting in error is made to fix the true line, neither party is precluded from claiming up to the true line when it is ascertained—and this is true with respect to both written and verbal agreements.

"Let us now attemptto make a practical application of our legal d eductions to the surveyor's experience; given an agreement entered into by the owners of contiguous lands to employ a surveyor jointly, to ascertain and establish their true dividing lines. The lines are traced pursuant to the agreement; each owner is present without expressing dissatisfaction, and each pays his part of the expense.

"Query: If the surveyor, by mistake, locates the line which is not the true one, are the parties aforesaid estopped from disproving its correctness? I answer: They are not estopped. In such a case, the surveyor acts only as the common agent of all his employers; and if he makes a mistake it certainly cannot be maintained that the mistake of the agent would affect the rights of any principal to a greater extent than would the mistake of the principal himself; and, as in other cases, a belief that the erroneous line is the true one, is a mistake of fact which would defeat a plea of estoppel based on the conduct of the mistaken party with reference to said line.

"But if to the above named agreement are added terms by which the surveyor is vested with a judicial power to finally determine and fix the true boundary lines upon the evidence furnished by undisputed monuments, and with the aid of his professional skill in obtaining and weighing this evidence, the parties to the agreement would be forever bound by it.

"In support of this view, the case of Thayer vs. Bacon is in point.

"The facts were: The demandant, the tenant and other adjoining owners signed an agreement in the following terms:

"'Boston, November 4th., 1858. We, the undersigned owners of wharves and flats east of Harrison avenue, are desirous of having our respective lines run, so that each may know our respective boundary, we severally agree to employ Mr. Alexander Wadsworth to run said lines and put up the stakes and marks to designate each lot, and we further agree to pay our proportion of the expense of the same.

"The lines were run in pursuance of this agreement; judgment was given in favor of the demandant.

"'If the instrument'" said Hoar, J., for the court, "'upon which

the defendant relies is to be construed as an agreement to submit to arbitration, the line between him and the plaintiff, the ruling of the court at the trial (in favor of the demandant) was wrong, and a new trial must be granted, but we cannot so construe it. * * * We seek in vain for the usual apt words to constitute a submission to arbitration. * * * So far as the paper shows, the service expected of Mr. Wadsworth was simply ministerial. There is no agreement to adopt and abide by whatever lines he may determine. Such an agreement, indeed, would not be necessary but would be implied by law from an explicit agreement to submit to arbitration; but where no such stipulation is clearly made, it does not seem to us to result from the employment of a surveyor to run lines.'

"Let me close this paper with a suggestion. In the case cited, the surveyor might have prevented a disturbance of the lines run by him by inducing the proprietors to include in their agreement a stipulation like the following:

"'And we further agree, jointly and severally, to adopt and abide by the lines run by the said Wadsworth under this agreement, and hereby fix and establish the same as the true boundaries of our respective lands, regardless of error.' From which we infer that it is in the power of our county surveyors to suppress much profitless, spiteful, and mischievous litigation relating to boundary lines; a kind of litigation which piles up costs, enormously out of proportion to the value of the property in controversy, and engenders neighborhood feuds which endure through successive generations.

MR. APPLETON.—"I would now call on Mr. Hodgman."

MR. HODGMAN:—

Land Laws and Decisions.

The committee on this subject having referred you to me, I may say that in searching the records for the purpose of finding new matter worthy of being put into the next edition of the Manual of Land Surveying, I have traversed much of the ground which was expected to be gone over by this committee, and by their request I give you some of the results of my researches. Of land laws I have found but little that is new to the Society, and that more a matter of curiosity than anything else, to us.

Some time early last year a gentleman in Tennessee wrote me in regard to the Manual, and asked if it gave the law relative to land processioning. He might as well have asked me about the land laws of the mound builders, for aught I knew about it. It was a new idea to me and I proceeded at the first opportunity to find out what it was. On searching the statutes of Tennessee, I found one laying down the law in regard to processioning land in the state. It amounts to this. When a man in

Tennessee wants to know where the boundary lines of his land are, he first puts up a notice of the time for processioning, and whereabouts he proposes to commence; 20 days notice must be thus given by posting these notices at the Court House of the county and at the voting place of the precinct in which the land is situated. He must also give 20 days notice to each of the parties interested in the matter.

He next delivers a sworn copy of these notices to the County Surveyor, who is authorized on receipt thereof to survey out the man's land —following: 1st, natural boundaries; 2nd, old marked lines, or 3rd, to re-mark the lines in accordance with the calls in the deed. Lastly he makes a correct plot and certificate of the survey, and returns to the Register of the county to be recorded.

In case of contested lines, he may call out a jury and take evidence. That is land processioning.

In the matter of decisions. I have met with the following which contain more or less of interest to the surveyor.

A boundary by the shore of a mill pond takes to low water mark.

Stevens vs. King, 76 Maine 197.

In a navigable stream, as the DesMoines river in Iowa, highwater mark is the boundary line. When, by action of the water, the river bed changes, highwater mark changes and ownership of adjoining land changes with it. The location of meander lines does not affect the question. Meander lines are not boundary lines.

Steele vs. Sanchez, 33 N. W. Rep., 367.

Krant vs. Crawford, 10 Iowa, 549.

Lockwood vs. R. R. Co., 37 Conn., 387.

A boundary stated in a deed as a line forty feet above the border of a river at high water mark, is not ambiguous and if disputed is to be fixed like any other fact by testimony and an examination of the ground.

Bresler vs. Pitts, 59 Mich. 348.

N. conveyed a lot according to a certain plat. The plat represented the lot as bounded north by a street, south by a stream; on the east and west by lines running from the street to the stream, with figures purporting to give the length of these lines. In fact, the distance to the stream was greater than indicated by these figures; held that the conveyance of the lot according to the plat included all the land between the street and the stream.

Nicolin vs. Schneiderham, Minn. 33, N. W. Rep., 33.

In Turner vs. Holland, the Supreme Court of Michigan gives riparian rights to owners of lots bounded by a bayou of Saginaw river, described by plat similar to the above. 33 N. W. Rep. 283.

Where surveys of 1837 and 1856 do not agree the former holds.

Palmer vs. Montgomery, 26 N. W. Rep. 536.

The deed of a city lot, and plat with reference to which it was made, called for the south line of Cherry street as the northern boundary of the lot. The line referred to had been established by the City Surveyor 37 years before and ever since acquiesced in. The other lots in the block had been bought, fenced and built upon on the assumption that this survey was correct. A more recent survey tended to show that the line was three feet too far north. Held that the presumption of correctness was with the older survey, and as the lot owner had got all he bargained for, and the later survey would cause the lines of the other lots to cut into the buildings, the older survey must prevail.

Wilmarth vs. Woodcock, Mich. 33 N. W. Rep. 401.

A description in a deed reads: The east ½ of the east ½ of the northwest ¼, and the east ½ of the east ½ of the southwest frac. ¼, etc, containing 50 acres of land; being the east half of one hundred acres conveyed by A. and B. to E. The south line of the tract is irregular on a lake and a line north and south through the centre of the tract would give one parcel nine acres more land than the other. Held that the language is apt and proper to divide the tract by a north and south line which would give to each 50 acres, or one-half of the whole.

A description of the half of the parcel of land, according to the United States survey, would have excluded the idea of equal quantities and fixed the dividing line in accordance with the act of congress. If any other line had been agreed upon between the owners as the boundary lide, it would govern the case.

Jones vs. Pashby, Mich. 29 N. W. Rep. 376.

Dart vs. Barbour, 32 Mich 267.

Heyer vs. Lee, 40 Mich. 353.

A description in a deed, if otherwise good, is not vitiated by the omission of the word rods to avoid tautology when the meaning is plain.

Taber vs. Shattuck, 55 Mich. 370.

I now come to a series of recent decisions, by the Supreme Court of Michigan of much interest to surveyors, and of vastly more interest to land owners because, to use the language of the Supreme Court of the United States, on one of the questions at issue, these decisions "will in their practical operation unsettle the surveys and subdivisions of fractional sections running through a period of some sixty-eight years." In quoting these decisions, I shall make such comments on them as seem to me to be called for.

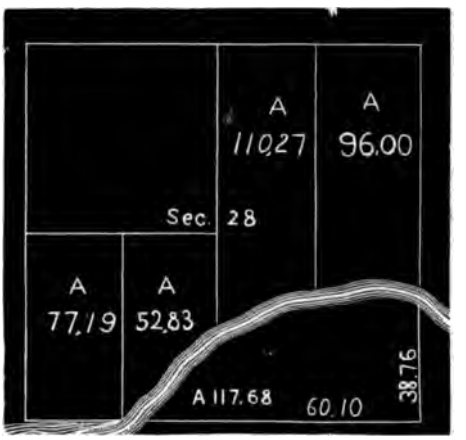
A few years ago, when the surveyors of Missouri pitched headlong into their Supreme Court for making an unsound decision, some of us thought that perhaps they were a trifle too zealous and put a little too much of their southern dash and vim into their onslaught upon error in

high quarters, and we may have looked down upon them just a thought, in the belief that we of Michigan had a Supreme Court who were above making any such palpable errors. If any of us did so, let us bow down in humility and ask their pardon, for truly we have reason.

The first of these decisions to which I call your attention is that of Wilson vs. Hoffman, 54 Mich. 246.

The land in question was that part of a fractional lot lying west of where the north and south quarter line of the section would be if extended across the fraction. The lot itself is described in the deed as the S. east Fl. ¼ of Frac. Sec. 28, Town 7, North, range 17 east, containing 117,68 acres according to the official plat of the government survey.

Here is a copy of the plat showing the entire fractional section.



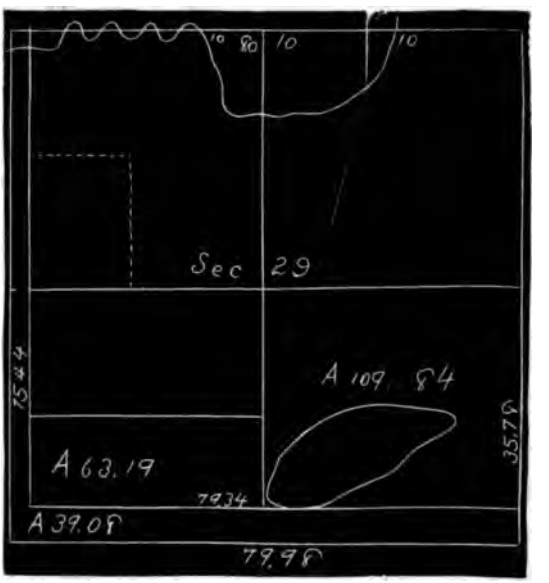
The original entry of the land was made by Hartford Tingley and was described as the south-east fractional ¼ of fractional sec. 28, containing 117,68 acres.

In deciding as to the ownership of this part of the fraction which extends west of the quarter line, the court says: "The land is all west of the north and south quarter line if projected through the section. No part is in the south-east quarter, *hence* the patent to the south-east fractional ¼ does not cover it." Of course the same principle applies to the fractions north of the river. The next decision in the same line to which I shall refer, is the Keyser vs. Sutherland case, commented on by me last year. For the benefit of those who were not present at the Grand Rapids meeting and have not seen the reports, I give a brief resume of the point in that case which is practically the same as in Wilson vs. Hoffman.

When the original survey of this township was made, in 1825 and 1827, by John Mullett, the ground where we now stand was an Indian reserve three miles square, conforming to the cardinal points of the compass, the boundary lines of which were about sixteen rods north and

three to four rods east of the regular section lines. The subdivision lines of the township were closed on this reserve line.

The south-west corner of the reserve was in Section 29, and took nearly the whole of it, leaving only a narrow fractional section like an L, the south arm of which was about 16 rods wide and the west arm about three rods wide. This fractional section was returned as a single tract without being divided. It was marked and retained on the official plat in that form and sold by the United States as a single tract. Two years subsequent to the survey and subdivision of the township, the Indian title was extinguished and the reserve subdivided. This made a second fractional Section 29, or as it was termed a north fraction and a south fraction of Sec. 29. The north fraction was subdivided on the plats and sold in the smaller tracts.



The south fraction was not subdivided on the plats but was sold entire. A contest arose in regard to a portion of the west arm of the south fraction which lay north of the E and W ¼ line. In deciding the case, the Supreme Court held that a south fraction could not extend north of the east and west quarter line; that if the Surveyor General returned it so it was contrary to law and therefore void.

As a matter of fact, when the Surveyor General made up the official plat and return of this township, this so-called south fraction was the entire Section 29, which contained only 39,08 acres. The law of 1820 was then in force unmodified, and it expressly said in so many words that

" fractional sections containing less than 160 acres shall not be divided.' This part of the act of 1820 was not repealed until five years after the official plat and returns of the township were made out.

We leave that branch of the question without further comment. The next decision in the same line which I shall quote is Palmer vs. Dodd. The principle in this case is precisely the same as in Wilson vs. Hoffman, with a question of riparian rights added; a question whether a fractional lot represented in the official plat as bounded on the south by a lake can be extended south across the east and west ¼ line to reach the lake, which is erroneously shown on the plat as extending north of the quarter line at the point in controversy.

The only part of the decision to which I wish to call attention at this point, is as to a fractional lot extending across a quarter line.

The Court says: " No grantee by patent granting a legal subdivision of land can derive title to land upon another legal subdivision. This we have decided in the cases of Wilson vs. Hoffman, 54 Mich. 246 and Keyser vs. Sutherland, N. W. Rep. 865, which were based on the decision of the Supreme Court of the United States in Brown's lessees vs. Clement's, 3 How. 650."

It will be noticed that in all these cases, as well as in the case of Clute vs. Fisher, briefly referred to in the Proceedings of 1887, the Supreme Court of Michigan treat the word fractional as having no descriptive meaning, and the boundaries of the land as marked in the official plat as having no value in determining what land is conveyed by the description. In every one of these cases the subdivision is described in the deed as being fractional, and in every one of them they treat that description as one of a regular subdivision. In Wilson vs. Hoffman, they say: " No part is in the southeast quarter hence the patent to the southeast *fractional* quarter does not cover it." In Clute vs. Fisher, they decide in effect that the boundaries of fractional lots extend just as far and are to be found in the same way as the boundaries of regular subdivisions—in other words, that so far as waters are concerned, there is no such thing as a fractional lot. Neither does it seem to them to be a matter of any importance that for 68 years the land department of the United States, under the advice of the Attorney General and the decisions of the Supreme Court of the United States, has conveyed by descriptions similar to those used in the cases quoted here, tracts of land described as fractional which extend beyond quarter lines—beyond section lines and even beyond township lines; has put men in possession of them and upheld their rights to the land which they had thus purchased

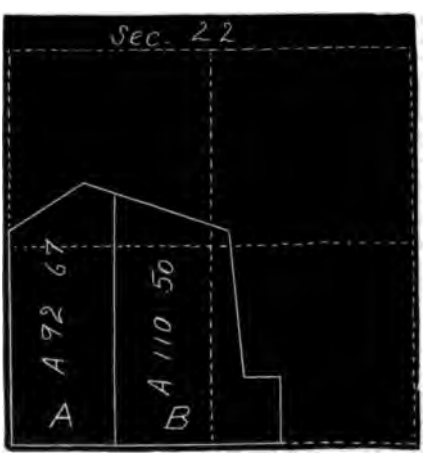
The land department of the United States has uniformally used the word fractional to designate irregular subdivisions and to show that the tract to which it was applied was not one of the regular subdivisons of the United States survey, and has uniformally carried out that construction by its acts. A fractional lot has never been limited by United States

authority within the boundaries of the regular subdivision from which it takes its name, but has in almost innumerable instances been extended beyond them.

Neither does the quantity of the land mentioned in the deed have any weight with the Supreme Court as tending to determine what land was intended to be conveyed by the deed.

The use of the word fractional—the construction put upon it by the land department of the United States—the uniform practice of that department down to the present time, in extending fractional lots beyond quarter lines; the mention of quantity in the description; the intention of the grantor as shown by his acts on the the ground—all go down before this doctrine that fractional lots shall not extend beyond a quarter line—that a grantee of land in one legal subdivision shall not go beyond it and take anything off from another legal subdivison.

Where does that doctrine come from? Fortunately we are not left in doubt on that point. We are told explicitly in Palmer vs. Dodd, that all these decisions are based on the decision of the Supreme Court of the United States in the case of Brown's lessees vs. Clements, 3rd Howard 650. It is by no means clear to my mind that the case upholds the doctrine. At the risk of repeating what I said last year I shall briefly refer to that decision again. Etheridge and Stone were the original settlers, pre-emptors, and purchasers of fractional section 22, figured in last year's report. Etheridge's patent called for "the S. W. ¼ of Sec. 22, containing 92.67 acres. Stone's patent called for "S. E. Subdiv. Qr. Sec. 22, containing 110.50 acres." These two descriptions were in controversy in Brown's lessees vs. Clement's. In the figure the full lines show the fractional section as it was returned on the official plat. The dotted lines show the section and quarter lines as they would have been if the section had been full.



On the part of the grantees of Etheridge two claims were set up. One was that under the pre-emption laws Etheridge was entitled to a full quarter section of land. The other was that as his deed called for the S. W. ¼ and the fractional section was of such size and shape that a regular southwest quarter could be laid out from it, he was entitled to it, and that the action of the Surveyor General in returning irregular subdivisons of the section, when he could have made one regular quarter section out of it, was contrary to law, and therefore void. The Supreme Court by a bare majority upheld these claims and decided the case on those grounds.

But there are no such claims in either of the Michigan cases. No pre-emption rights enter into the controversies. There was and could be no claim that the Surveyor General could have made a regular quarter or half quarter in either one of the cases if he had desired to. The grounds on which that case was decided are entirely wanting in these.

But supposing they were not, the decision itself and its doctrines are unsound and were repudiated 30 years ago by the very same court which made it, in a second trial involving the identical same land which was in controversy before. In Gazzam vs. Phillips, lessee, (20th Howard 572) the Supreme Court of the United States decided that the sales to Stone and Etheridge "were made in conformity with the plat of the survey then on file in his office;" that "the court had no right to determine the tract and quantity of the land granted by the supposed equity under the pre-emption laws instead of by the description of the patent." They further decided that the Surveyor General had a perfect right under the law to make the subdivision of the section that he did and according to which the sales were made. They say on that point: "The question came before the Secretary of the Treasury and *before us* in 1837 and the construction first given and the practice of the Surveyor General under it confirmed." They also quote and endorse the opinion of Attorney General Butler to the same effect. They say in effect if not always in the same words, "This Brown's lessees vs. Clement's, decision is all wrong. We settled that years ago. The Act of 1820 says that those fractional sections which contain more than 160 acres shall be subdivided under such rules and regulations as may be prescribed by the Secretary of of the Treasury. He made a rule that they shall be divided by north and south or east and west lines so as to preserve the most compact and convenient forms—quarter line or no quarter line. Attorney General Butler was asked if the Secretary had the right to make any such rule in cases where there was land enough for a regular subdivision, and he said the Secretary had the right. Then they came to us about it in 1837, and we told them the same thing. So the rule has been followed ever since it was made June 10, 1820. Here were Etheridge and Stone who took up the land these fellows are quarreling about. Etheridge's deed calls for the S. W. ¼ containing 92.67 acres. There is land enough for a regular

quarter section there, but he cannot get it all, for he didn't buy nor pay for it. It is perfectly plain from the plat and description what he did buy, and though he can't have all the S. W. ¼ he shall have so much of the N. W. ¼ as the plat shows belongs to him. Now, as for Stone. His deed says the S. E. Subdiv. ¼ containing 110.50 acres, and he paid for that much. There is no such amount of land in the S. E. ¼, but it is plain from the description and plat what land is meant and he shall have it. On his description of the S. E. Subdiv. ¼, containing 110.5 A., he shall hold land in every other quarter in the section because he bought and paid for it; the government sold it to him and meant that he should have it, as it had a right to do. It is not pleasant to go back on one of our own decisions, but it is better to do this than to adhere to a principle which we think unsound and which in its practical operations, will unsettle the surveys and subdivisions of fractional sections of the public land running through a period of some 38 years. We cannot adopt that Browns vs. Clements decision nor apply its principles in rendering judgment in this case."

So they buried the unjust decision 30 years ago, but here in Michigan it has been resurrected, and a whole row of decisions based on it tending in their practical operations to unsettle the boundaries of 10,000 to 12,000 tracts of land. Kalamazoo county alone has 110 or more tracts affected by it and assuming the county to be a fair average of the state, the number must exceed ten thousand.

It would be well for those who are the losers by these decisions to chip in and have a case carried up to the Supreme Court of the United States and have a stop put to this kind of business. They had much better do it than have the land which they have bought, paid for and occupied in good faith under titles from the U. S. Government, taken from them and given to others who never did buy or pay for it, as has been done in several cases.

I wish that criticism of the decisions of our Supreme Court might legitimately stop here, but unfortunately for the owners of eleven sections in every full township in Michigan, it does not.

I now come to the case of the Commissioner of Thompson township vs. Beebe.

Some of you will remember the case of the surveyor who was sued for damages for running an erroneous line by which a considerable work done on a road was claimed to be lost, and our Supreme Court decided that he was liable for the damages. I conclude that he did not pay them for the same case seems to have got up to the Supreme Court again, the Surveyor Beebe apparently claiming that he made no mistake and that his line was right. The lower court sustained him but the Supreme Court thought differently, and I call attention to the decision because it overthrows about the only thing left of the United States Land System in this state which it seems among the possibilities that they could over-

throw. When they shall decide that the fractional half of a quarter section next the north or west boundary of a township means the half of the area I think the work will be complete.

Here it is—from the N. W. Rep. vol. 27, P. 713:

"The east and west quarter line as surveyed by the defendant, came out on the township line between sections 31 and 36, some ten or twelve rods north of the quarter-post found standing on the township line which is also the dividing line between these two sections There was no survey ever made of the west line of section 31, except the survey of the east line of 36, which was in fact as appears from the field notes, a survey of the township line and as much a survey of the west line of 31 as it was of the east line of 36. *Consequently* the quarter-post on the east line of 36 was necessarily the quarter-post on the west side of 31, and the quarter-line which should have been followed by the survey of the defendant, is established by a line drawn from the quarter post on the east side of section 31 to the quarter post on the township line between sections 31 and 36. In fact and in law the quarter-post is identical and the same for both sections is being a township line."

Please bear in mind that all the original surveys in Michigan were made upon the system by which two sets of section corners were established on all the township and range lines, while I read you the following quotations. The first is from the Instructions to Surveyors General by Commissioner Edmunds, P. 9.

"Quarter section corners are not required to be established on the *west* boundary of the western tier of sections in a township, nor on the north boundary of the north tier of sections in a township south of and bordering on a standard parallel. The resurvey of *township*—standard or base lines—by the Deputy Surveyor for the purpose of establishing such quarter-posts, is unnecessary and will not be paid for."

The next is from Instructions to Deputy Surveyors of the United States for the district of Illinois and Missouri, 1856, P. 50. "Range lines are run north or south from the base line and corners for sections and quarter sections are established thereon at every mile and half-mile for the sections and quarter sections on the *west* side of the line *but not for those on the east side.*" On township lines "the corners of sections and quarter sections are established at every 80 and 40 chains for the sections and quarter sections on the *north* side of the line *but not for those on the south side.*"

The next is from the Instructions to Surveyors General, by Commissioner Williamson, of May 3, 1881, page 40. "Where there are double sets of section corners in township and range lines, the quarter corners for the sections south of the township lines and east of the range lines *are not established in the field by the United States Surveyors*, but in subdividing such sections said quarter corners should be so placed as to suit the cal-

culations of the areas of the quarter sections adjoining the township boundaries as expressed on the official plat."

My last qnotation is from the law of Feb. 11, 1885, Rev. Stat., Sec. 2396. First.—"The corners of half and quarter sections *not marked* on the surveys shall be placed as nearly as possible equidistant from those two corners which stand on the same line."

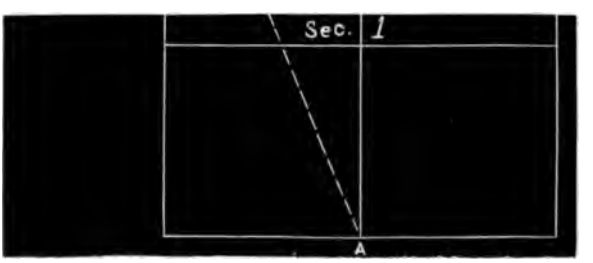
In this state, so far as I have examined the plats, the calculations of the areas are made upon the theory that these quarter section corners shall be placed just where the law requires them to be, midway between the section corners.

Nothing which I can add will emphasize the flat contradiction between the decision of our Supreme Court in this case on the one side and the Instructions to United States Deputy Surveyors and to Surveyors General, and the laws of the United States on the other. When we come to look the matter over and see how far-reaching in their results are the several decisions I have criticised, we find that Judges Champlin, Sherwood and Morse, in the few years they have been on the bench, have written a series of decisions that will in their practical operations, unsettle the surveys and subdivisions of fractional sections covering one third of the land in Michigan and overturning a system which has certainly been in operation in this state ever since 1825, when E. Tiffin retired from the office of Surveyor General of the north-west territory.

I will simply add one illustration of a section in this county to show you how it works.

CORRECTION.

Page 45, first paragraph, for "Feb. 11, 1885," read Feb. 11, *1805*.



The diagram is a correct copy of the official plat of Sec. 1, T. 1, S. R. 9 west, with broken line added. The jogs between the section corners

you will see are a little over 2-5ths of a mile. The line A B shows the quarter line as it would be located by law and the instructions of the Commissioner of the Land Office. The line A C shows the quarter line as it would be located by the Supreme Court of Michigan. There is no statement of the facts in regard to the survey of the line and location of quarter corners between sections 31 and 36, on which their judgment is founded in the decision quoted that is not equally true of the survey of the line and location of the quarter corners between sections 1 and 36 in this case, and I again quote their language to show how it applies, only changing it to correspond with the numbers and location of the sections.

"There never was any survey of the north line of section 1, except the survey of the south line of section 36 which was, in fact, as appears from the field notes, a survey of the township line and as much a survey of the north line of section 1 as it was of the south line of section 36. Consequently the quarter post on the south line of 36 was necessarily the quarter post on the north line of 1, and the quarter line is established by a line drawn from the quarter post on the south line of section 1 to the quarter post on the township line between sections 1 and 36. In fact and in law the quarter post is identical and the same for both sections, it being a township line."

The premises are just as true in the one instance as they are in the other. The conclusions are absolutely false in both.

Question.—What is to be done about it?

Answer.—Appeal to a higher tribunal.

Cases have been there and can be got there again in the same way.

I trust that nothing that I have said in criticism of these decisions will be taken as an attack on the persons of the judges who wrote them. One of them was my classmate and friend in college. Another is an honored citizen of this city, whose friendly feeling for me has expressed itself in acts on more than one occasion. I honor his sterling integrity, uprightness of purpose, public spirit and unyielding tenacity in holding fast that which he thinks is right. But believing as I do, and as I think with good reason, after years of careful research, that these decisions are wrong from the beginning, and tending to interfere with the just rights of thousands of my fellow citizens, I should be false to myself, false to the citizens of Kalamazoo County, who for 20 years past have honored me with their suffrages, false to the society which assisted me to make these researches, if I did not do what I could to right what I believe to be a great wrong.

At the close of Mr. Hodgman's paper a committee of three, consisting of Messrs. Teed, Gillett and Hemenway, was ap pointed to examine and report on such questions of practice as might be submitted.

The convention then adjourned for the day.

WEDNESDAY MORNING SESSION.

PRESIDENT STEELE.—"I think we had better come to order. I know that you are enjoying yourselves talking about those beautiful instruments, but we have some lengthy papers and a good deal to do. Since we organized last night there has come to us several exhibits to which I wish to call your attention and ask you to prepare the way for a report on the exhibits through a committee. Nothing has been done about it yet. This is a volume on the theory and practice of surveying, donated to the Society by Prof. J. B. Johnson, of St. Louis, Mo.

Here is a donation from the Columbus Sewer Pipe Co., of little memorandum books which are very convenient. Help yourselves to them. I also wish to call your attention to several copies of the Engineering News, sent to us by the publishers. You do not need any introduction to that paper. It is doing a good deal in Michigan and I feel very much like commending it and showing it.

We have also from Mr. Collar some photographic views which are very fine indeed. These come right in line with what I was speaking of last night, the art of photography being so perfected that views of constructions in their various stages may be taken with exactness. We also have turned over to the Society the very aged instruments, the gift of Mr. Coffinberry. This scale is said, I think to be 150 years old.

I will call upon Mr. Hodgman for a report from the committee on Manual, after which we will have a paper from Mr. Sears."

MR. HODGMAN.—"There is but little to report. There is a matter of $93.20 remaining to be settled between the Society and the committee. According to the arrangement made with Prof. Bellows at Ann Arbor, the Society or its members were to be furnished Manuals at a price which was afterward fixed at $1.75. The Society were to take 300 copies, aid what they could in the sale, and the money advanced to pay the expenses of the committee was to be refunded at some time. I do not know how many Manuals have been taken by the Society, but probably not more than 100. The first edition has been entirely sold out and Prof. Bellows has just about got back the money expended on it and nothing for his time. I am now preparing for a revised edition in which the errors, so far as we have been able to learn them, will be corrected and new matter on chain surveying, curvelinear surveying, mining surveying, map drawing, court decisions, platting, monumenting, etc., will be added. We expect to have it out during the coming season. Price $2.50."

PRESIDENT STEELE.—"If there are no remarks on the Manual we will hear the paper prepared by Mr. Sears, read by Prof. Greene, on

Highways and Highway Bridges.

EAST SAGINAW, Jan. 14th, 1888.

TO MESSRS. INNES AND KENT,

Members—Committee on Highways and Highway Bridges.

Michigan Engineering Society Gentlemen:

I see by the last report of the Michigan Engineering society that Innes, Kent and Sears, were honored and named for committee work on "Highways and Highway Bridges." I suppose this means that we shall do *something* to interest and instruct our fellow members, and through them, the general public, by describing the present method of forming the best roads and bridges, or by suggesting remedies for past errors; show them how to improve on "the old," and construct better works in the future; to meet the wants of an intelligent and growing population. How shall we do this, and who shall do it? I am at the head of this committee, but with increasing years, failing health, and more work in hand than I can master, it is impossible to snatch an hour or fraction of a day, to devote to this subject. My impression is that we should come together, talk the matter over, exchange views and outline something for the coming meeting. Can we do this, and when and where shall we meet to discuss "Highways and Highway Bridge Construction?"

On roadmaking, my own observations go to show that where the area covered by the road is thoroughly *drained*, the road is made. I don't mean by this that drainage alone will fit a surface for continuous and heavy traffic at all seasons of the year, without some artificial covering of broken stone, gravel, plank or paving; but, it is an indispensable condition. It lies at the base of all road making and the singular fact is, that, while a majority of men know this to be true, they will not *act up to their knowledge.*

It requires more effort, pluck, means, a keener sense of the good, clean, economical and useful agent, than the average man is willing to put forth. We are too prone to build for the day, to meet present and urgent needs and forget to shape the work so that what is done becomes a part of *the completed whole*, so arranged and placed, that *no effort* is lost. We sacrifice heavily in both labor and materials, and never *succeed* in making a passable highway *without* good drainage. The best "highway work" this committee can do, in my judgment, is simply to call the attention of the young members to the importance of thorough and perfect surface and sub-drainage of the road bed. We want no dead water standing in the ditches along the roadside—they should be so arranged as to keep this water in motion and the sub-drains so placed

that, when the transient floods have passed off by open ditches, the subsoil water *can and will* be kept moving on a plane, at least four feet below the finished surface of the road-bed. Wherever we find the subsoil composed of sand and gravel and the water line lowered, natural drainage takes place and the road builder has an easy task. I have omitted saying how the highways should be constructed, which would depend upon the location, character of soil and varied circumstances, as to cost of materials, length of hauls, etc.; and also as to maintenance, which, if the traffic is considerable, should be under the direction of a competent, trained and skillful man, and should be attended to with regularity and promptness, and no faults allowed to grow. Daily supervision with a patch here, and stroke or stitch there, wherever slight faults appear, and material at hand to make these in a rapid and economical manner, is the true method of maintaining a good road.

A system similar to that pursued on railways for the proper maintenance of track under heavy traffic is the true one. Very few of our roads warrant this outlay at the present time. We are in a *transition* period and just beginning, as population increases, to feel the necessity for better roads connecting the rural districts with the growing villages and large commercial centers. The plank road and the gravel road, constructed by corporations, and operated as toll roads for the movement of freight and passengers, has been superseded and run out by the general adaption and use of railways, which now connect almost all important towns in the state. Along the line of these old roads, in many localities, improvements in farms, farm buildings, hotels, stores and small villages grow up, sustained and kept alive by the traffic on the highway. The railway comes, the traffic vanishes, the villages and hotels gradually die out and "the road," abandoned by the corporation, becomes in a few years even worse than *the common* highway. It is subjected to heavier traffic still than the common road, but, for want of regular repairs it becomes almost impassable at seasons of the year when good roads are most wanted. How many of us have passed over such roads when *the toll gate* and *the gate-keeper* were still in place, taxing the public, but the repair gang had abandoned the field for six months or more, and with what supreme satisfaction we halt, take off the gloves, unbutton the coat, find the purse, and pay "the fee!"

We have done this often, but nearly always mentally damned the corporation. Much of our hostility to corporations has grown out of this fact, and what does it prove? Not that the corporation was bad, when it supplied *a good road* at a fair price, but, it became bad in our sight the moment repairs on the road were abandoned, and it *failed* "*to do its duty.*" Applying this to the general public, after traveling over and viewing their roads in the months of March and April, which are often knee deep in mud simply for *want* of proper *drainage*, we are honestly inclined to damn the whole country, and measure the intelligence and thrift of the

farmer by the roads he tolerates around him. We indulge this feeling, particularly if the country is populous, land good and well improved, and lacking only the element of good roads to make it pleasant and profitable. To improve our roads, the leading arteries at least, some artificial covering is needed in the shape of gravel or broken stone. Gravel in Michigan is abundant, but not uniformly distributed. Where most wanted we have none, and *cannot get it* for want of transportation facilities. How shall we get these? Let the owners of valuable lands unite with progressive capitalists in the villages and large towns, and utilize the steam shovel and railway, as suggested in my short article "On Roads, and How to Make Them in the Saginaw Valley," read before the convention at Saginaw, in 1885. I saw a splendid field for "this system" in the spring of '86 between Novi, Farmington, and Detroit. The old state road leading from Detroit to Lansing is still a toll road, nearly played out, particularly the Detroit end. At Farmington, eighteen miles from Detroit, are splendid mounds of gravel. Why don't they utilize it? The gravel or plank road company hauled it by teams as far as it was practicable to do so in the direction of Detroit, and there *stuck in the mud.* The muddy end lies near the metropolis of the state, and surrounding the capital city in March and April, if you want to see *muddy lanes* on high priced lands—a disgrace to civilization—go and see them, but *strap* your boots securely to the body, or you will leave them in the mud and go home barefooted. Does not Detroit pay roundly for her sand and gravel and street improvements, and has she not miles of streets in the outskirts that want sub-drainage and a good coat of gravel? Why don't some of her leading capitalists organize a company and build a light railway to these beds of gravel, making first a road to the city, supply the roads branching from it for two miles on either side, and then gravel miles of her outlying streets? In a location like this there is immediate work sufficient to pay for the plant, and by the time the work is executed the road would pay a fair interest on the investment, bringing fresh milk, fruits and vegetables to the market, and supplying the wants of suburban traffic. If it won't do this, let them transfer it to a new field and continue the business of road making. Let the capital city of the state do this; set the example as to the making of cheap and good roads, and she will find plenty of imitators. People will pay for *good things*, when they are fashionable. Let her (she is able) start a fashion that *leads* to economy, growth and beauty, instead of waste. The capitalist has grown rich robbing Michigan of her magnificent forests under "bounty acts," and has he no greatness of soul, no philanthropy in his composition; and is he now unwilling to turn *the scales* for a brief season and aid the farmer to inaugurate good roads? Shame on him, if he is unwilling to do this before his millions are squandered on fine houses, horses, livery, and ornamental parks and grounds fenced in against the vulgar crowd that surrounds him, carrying heavy burdens *all* and worrying through muddy

lanes. We hope and trust there are "good men" and true among them, who will banish selfishness for a season, show a laudable public spirit, and take hold of "road making" to beautify their homes and the country around them.

HIGHWAY BRIDGES.

I cannot do this subject justice for want of time, but desire, before expressing my own views, to call the attention of the younger members of this society to papers read before our neighboring societies, published in their annual reports, as follows:

1st. "The Oldest Long Span Bridge in Ohio," paper by Chas. B. Cook. Ohio report for 1887, pages 46 to 53. This paper shows what *can* and *should be done* with wooden bridges, where they rest on substantial supports, covered and properly protected.

2nd. The paper by M. J. Butler, printed in the "Proceedings of the Provincial Land Surveyors of Ontario," for 1887, pages 93 to 99, is a good one. He says "a poor iron bridge" is about the worst investment any county can make, and as a commercial axiom it may be written "that the supply will always suit the demand," and when our county officers begin to buy the cheapest offered, because it is the least in first cost, then we will get poor, defective traps like our cousins across the line."

3rd. Foreign to the above caption, but good for the young members interested in railway construction, is the paper by Edward Hill on "Rail way Trestles." Illinois report for 1887, pages 105 to 131."

Comments: I would place the bents 14 feet between centres instead of 15 and 16 feet; omit corbels always, except under stringers that are covered and fully protected, and put in *lateral* as well as sway braces. Where piles are long enough to be capped at grade, make large tenon on pile head, 4 inches thick, 8 to 10 inches wide and 12 inches long, and use instead of solid cap two pieces 5 x 14 inches, 14 to 16 feet long, bolted to head of piles. This makes a better cap and will last from two to four years longer than the solid cap 12 x 14 inches.

Now, young gentlemen, if you have not read the papers above mentioned, please read them and make use of the good points therein to guide you in future practice.

MICHIGAN HIGHWAY BRIDGES.

We have no statistics at hand to show any approximation to the number and cost of the highway bridges in Michigan, and neither do *we* know how to go to work to find this information. A committee with money, and time to canvass the state, might arrive at some rough approximation as to number, kind and cost, but, unless you were hunting for what to *avoid*, instead of *imitate*—(with a few honored exceptions, where they have been skillfuly planned and honestly constructed)—the *game* would be hardly worth the seeking. In some of the older sections of the

state, where the community are fortunate enough to possess among them a local engineer of some repute, and they have *used* him and obeyed him, "the tin pan bridge" has been very materially improved and fair structures exist. These are the exceptions, however, and not the rule. As I see them in passing through the state, the classification should run as follows: Good, 1; bad, 2; worse, 10; worthless, 20. Generally speaking they are poor, and *one-half* the money put into them thrown away—absolutely wasted. Who is responsible for this state of things? It must be "the people," their agents and law makers. We can organize to do many things well, why can't we organize and name *competent* agents to do this work? We have law makers enough in both state and county, and with intelligence among "the people," and an honest desire to get the best results attainable for the money expended, why can't we have in every section of the state, substantial, durable bridges? Responsible bridge companies are abundant, splendidly equipped for construction purposes, and competent engineers can be had to make plans, specifications, and supervise the work. Why not use them to the best advantage? How are they used, and are they used at all? A village, township, county or city board want a bridge. How do they get it? A few *wiseacres* among them, who know as much about the construction of a bridge as they do about building a watch, a locomotive, or a cotton-gin, arrange a "programme," specify their wants and advertise for the bridge. They get competitive bids from a number of bridge companies, who supplement the tender by sending an oily tongued negotiator on the ground to explain *his plan* and *secure the job*. The best talker and most skillful manipulator secures the work, particularly if he happens to be *the lowest bidder*. He gets it, too, without any *honest* and *fair comparison* as to "the merits" of the several designs submitted. They *cannot* afford to pay a competent, trained, reputable and skillful engineer, who has made the designing and construction of bridges a special study and his life work, to pass upon the merits of the several plans and advise them what *to do*, because that will *add to the cost*. They want *a cheap* bridge, and they generally succeed in getting their wants supplied. Now the common horse sense of the taxpayer, if he has no better sense—and we think he has—should *rebel* against this system. Is it the object of the taxpayer to waste funds simply because they are public funds? Is that the way men of sound judgment and well balanced intellect pursue business, conduct their own private affairs? If the farmer has a sick horse, and a valuable one, what does he do? Does he go for the adept in bridge construction, or the skilled veterinary surgeon? If his child is in danger why does he send for a doctor? Why don't he call on one of these bridge committees, they know almost *everything* that *can be known?* I admit that Americans are smart, particularly the Michigander—many of us are *too smart*, we hardly know where smartness ends and wisdom begins. A prudent and just man, looking down upon us, and *knowing* the motives that rule the

governing class in this country to-day, might honestly exclaim: "Egotism and self conceit, unholy combinations, monopoly, jobbery in county, state and nation, where art thou? Where is thy home?" Hovering over America just now, and in *that particular spot* called the United States, governed by a skillful crowd of six-penny lawyers, gifted in nothing but "*gab.*" Men, who, possessed of the talent to talk, are wanting in *sound morals* and the broad culture the statesman should possess, have an itching for popular applause, and "bend the knee, in order that *thrift* may *follow fawning.*" Look at your Senate. How many noble Romans among them whom the people respect and love? Not a baker's dozen. What do we worship in this land anyway? Is it moral power, philanthropy, purity of character, honest work, devotion to principle and duty, or *mammon?* Money and the power it brings, it would seem, is "the God" among us just now, and it makes no difference how obtained. Get money, money *makes* "the man." We admire the lines of Pope: "Worth makes the man, and want of it the fellow;" and of Burns: "To catch Dame Fortune's golden smile, assiduous wait upon her, and gather gear by every wile that's justified by honor; not to hide it in a hedge, nor for a train-attendant; but, for the glorious privilege of being independent." And we have: "Ye cannot serve God and Mammon."—*Mat. vi.* Now, what has all this moralizing to do with "the bridge" we are talking about? You go to the bottom of it, young man, and unless *you are sound* in every part, and set a sound example to your friend and brother, state and county will continue to build grade No. 4 "*worthless*" highway bridges for years to come, and future sons and daughters, if they are honest, will rise up and shower curses instead of blessings on your head.

IRON BRIDGES — FAULTS.

The principal faults in the iron highway bridge, as now constructed, are, "want of iron" and *good* paint constantly applied to preserve what little there is. Rust eats up iron very fast, and where the members are thin and light in section they are soon destroyed. It is false economy to construct *light* iron bridges, under the delusion that we *now have something permanent*, and *all* watching, care, trouble and expense is *done away* with.

They should be ample in section, and so arranged that all the parts can be reached with paint brush and paint, and paint of good quality applied, to prevent accumulation of rust and waste of metal. One year ago the city of East Saginaw constructed a fine iron bridge across the Saginaw River. (I inclose a copy of the specifications for your examination.) It was erected by "The Smith Bridge Company," of Toledo, Ohio. Everything was well and properly executed, as we supposed. To-day the paint is *scaling off* in great flakes, and "the bridge" needs repainting. Now, seriously, is there any good paint in the market? Are we Americans *honest* in anything? I want the theoretical and practical chemist at

Ann Arbor, or Lansing, to tell the people of the state how to detect *some* of these frauds, and *punish* the makers and vendors of them? Can they do it, and will the law-makers aid them?

Talk about rigid specifications, skillful plans, nice adjustment of strains and sections, and all that. What are they worth, when every man in the creation of the plant is trying "*how not to do it?*"

SHORT-SPAN WOODEN BRIDGES — FAULTS.

The main fault connected with all short-span wooden bridges — the two-panel truss, three-panel truss, four and six-panel, or queen post truss, is this, viz.: The trusses are *so low* there is no means of keeping them in exact vertical or horizontal position. You cannot connect them together at the top; there is no room to put braces on the inside, on account of the narrow road-way, and none generally provided on the outside of the truss. The abutments decay or settle a little at one corner, the truss is immediately thrown out of true line and position, shearing, warping and distortion follow, and "the bridge" becomes a wreck in a short time, even before the floor beams have decayed or failed. Now, if the trusses could be kept in exact line (vertical and horizontal), as first placed, when the abutments were new, the main braces and straining beams would outlast two sets of floor beams in almost all cases, and we should get a comparatively cheap and durable bridge. Another vital point, where the main brace rests upon the chord. Place a cast-iron or wrought-iron plate on top of the chord. to receive foot of main brace, and you will add about *one-half* to the life of the structure. An iron plate should be placed, also, between the abutting ends of the braces, or between the main brace and the straining beam, Use iron spools or plates for packing all members where these are left uncovered. There is no economy in wooden bridges, where the vital parts are exposed to sun and rain. For these short-span bridges, in the older sections of the state, I would prefer "iron plate girders" in all cases. These can be made to stand up, and if the abutment falls you can pick up the girder and place it on a new one; provided, *that paint brush* is used at the right time, and *good paint* is discovered.

For spans over 40 feet and under 150 feet, I would use combination "thro' bridges," with iron floor beams. The vital part of the wood in these bridges — end posts and top chords — can be cheaply covered and made to last forty to fifty years, if built beams are used, made up of thin, deep skeins, so as to season quickly.

Now, good friends, the old man is talking too much; if these views seem to be those of the "Pessimist," remember I always praise a good thing when "I see it," and, like the average American, think I have the gift of knowing *when and where I see it.* Yours truly,

WM. B. SEARS.

THE PRESIDENT.—"Gentlemen, I wish to commend this especially because it brings our attention to one thing, a committeeman of this Society trying to do his duty. We have members of standing committees in this Society who do not come here. They think somebody else will come and take their place and do their work. Members should be right on hand. If they are on for a report, make it. The success of this Society depends on each member doing his full duty. Mr. Sears, out of a sense of duty, and over-burdened with care, has prepared this paper for us, and if every one would do in that way we would be running over with facts and valuable data. Are there any remarks on the topic?"

MR. TEED.—"One trouble with our roads is that they don't get started right. If the location is bad, no amount of graveling or draining will make a good road. Our whole road law and system is bad. Under it there are thousands of dollars wasted every year. We have a Highway Commissioner in each town who has the whole control, and puts the money where he wants to. What we ought to have is an entire new law. The laying out of roads and the work done on them, and appropriation of money, should be under the supervision of a Board of Commissioners for the whole county. That Board should not all be appointed by one man, and they should have pay enough to get a man that knows something about the business, has some ideas and some responsibility. My idea would be to have three Commissioners, two of them to be appointed by the Board of Supervisors for say three years, and the County Surveyor for the third one, and have every thing done under intelligent supervision. As it is now the roads are worked a little piece here and a little piece there. The overseer does not get much pay and is not expected to get much work done. A lumber firm near where I live has a large tax to pay—about $1,000 road tax—and one year they got the privilege of doing the work to suit themselves on a road they used a great deal, and they made more good road with it than all that had been done in that town before. They made ten times as much good road as was ever made in the county with the same amount of money."

THE PRESIDENT.—"While Mr. Teed has been talking, I have been thinking the cost to Michigan of poor roads. We had a sample of it near Traverse City, of about eight miles. It ran along the sandy beach and only small loads could be drawn. The wheels would sink deeply in the sand, and there was no avoiding it. They went at it and built a road, raising a tax in three different towns that were affected by it, and they made that road in such shape that it is now as good as a pavement. You can take as big a load over it as you can in the streets in this city. Now, what is the gain? It is the difference between one thousand pounds and two thousand pounds. You will find that these bad roads are like toll roads. They charge toll every time that a team passes over them. They will not permit me to take half as much as I could if the road were in

the proper place and properly made. What do bad roads cost the state? It is over half of all the wheat product of the state. Now what are we doing? We let men go on and lay out roads, and lay out money on them, and engineers who have an eye to where a road ought to be laid have nothing to say about it. On the old road between Traverse City and Silver Creek there is a hill that it was impossible to haul a decent load over, such as could be hauled over all the rest of the route. Mr. Goodrich was going to do some heavy hauling one winter, and he employed Mr. Hodgman's brother, who used to reside there, to go with him and see if they could not find a better route, and they got a road there that they haul down enormous loads of logs. There are thousands of such instances all over the state, and we ought to bring our forces to bear upon the authorities to regulate and establish roads where they ought to be. Bad roads are a monstrous expense in the state, and I am confident the citizens do not realize it, or they would take more determined steps to perfect them."

MR. SKEELS.— 'It seems to me that one mission of this Association is the making of better roads, and that it would be good sense for us to memorialize the Legislature to have it done in this way. Ask them to have the Board of Supervisors appoint a County Engineer, put him under sufficient bonds, and give him the charge of all road making and the expenditure of money on roads. As individuals we are supposed to understand the best methods of locating and making. As engineers it is our business to know it. We want the people to know that our knowledge is at their command, if they will pay us for it the same as they pay for other knowledge of equal value."

MR. HODGMAN.—"A few years ago I undertook to make an estimate of how much one hill on the Comstock road out of this city cost the public annually I estimated as nearly as I could the traffic passing over it, and the lost time of business men riding back and forth over it. I have not the figures by me now, but as nearly as I can remember it amounted to over ten per cent. on $50,000 a year. The road rises about forty feet over that hill, and then falls as much on the other side. If the road had originally kept along side the Michigan Central Railroad, which it follows for twelve miles back, it would have shortened the distance and got a level line at a trifling expense — much less than it has already cost where it is. It would be cheaper now for the public to pay $40,000 to have about half a mile of road moved to the side of the Michigan Central Railroad, than to leave it where it is for nothing. This shows the importance of a proper location of a road. We should be just as careful and employ the same principles in locating a highway as we would in locating a railroad, especially in a rough country. In some of our sister states, notably in Ohio, the County Engineer system is in operation, and in my attendance on the meetings of their Engineering Society the engi-

neering of highways and drains has been the most prominent topic of discussion among them. The good results of the system are to be seen in their splendid pikes, where twenty years ago were impassable quagmires of clay; and in their magnificent systems of drains, in which they are years and years ahead of us in Michigan."

MR. H. C. PEARSONS.—"Your Yankee has found out that it is no further around the kettle bail than it is over it. We can go around the hill several times without any greater cost than it would take to go over it once. And now, as has been said, we ought to have a county officer with authority, and it ought to be within his power to accommodate his road to the country. But to do this we must educate the people. Now, in a certain place, there is a gravel road to be built, and a certain individual applied for the position of constructing engineer of that road. After a time he got a letter saying they had no work of that kind to be done — did not need any such services as that. Now, until that idea is got out of the minds of the people we never can have good roads."

THE PRESIDENT.—"If there is no further discussion we will call for the paper on Village Plats, by Mr. Sherman. It will be read by Mr. Hodgman."

Town Plats.

Gentlemen: If you want advice about how to make town plats, *ask the Auditor General.*

It matters not how much time and money may have been expended in learning how to make town plats, nor what university is the mother of your learning; if you undertake to make town plats for record in Michigan, you will early and often find it necessary to *ask the Auditor General*, and the most enlightened information received through any other source will not avail you. I said *ask the Auditor General* early and often, advisedly, because it has been my experience, and that of others whom I know, that advice received from the supreme source mentioned applies in no case, certain, beyond the particular instance in hand. Were such the case, the decisions of this court of last resort would soon cover the whole range of the subject, and we could have them arranged, codified, annotated and indexed so that we could read on the run and acquire a fixed method of making town plats for record. But then, in such case, *nobody would ask the Auditor General*, and that function of the department would become perfunctory.

I suppose the enactment of the present statute was intended to provide a beneficent security to posterity, against unintelligible, or partly intelligible, or ill drawn, or dirty town plats, and against the doubts and litigation arising therefrom. A posterity duly grateful for such foresight and for the microscopical and shifty flaw-picking this generation is undergoing, will be a posterity we might be proud to beget.

But, gentlemen, so long as the present statute stands, we shall perforce continue to *ask the Auditor General* and follow the dicta of that departmental sixth-wheel to the Supreme Bench, and I submit to you that the present statutory attempt at more complete records of town plats has overshot the mark, and placed the whole subject upon *the opinion of the Auditor General*, which is an insult to our intelligence and an encroachment upon our citizenship, since it places the department above all law.

Could we not follow a statute containing all necessary directions for making and recording town plats, without the scrutiny of any department? If the Auditor General needs plats by which to correct tax returns, does it follow that he should make all town plats? We have reason to know that these departments are self-aggrandizing institutions, controlling legislatures and superior to laws. How long before town plats can only be made by the Departmental Surveyor?

Gentlemen, it seems to me it is time to ask that the business of making town plats shall be restored to the people. Let us employ our best efforts to that end.

J. E. SHERMAN.

MARQUETTE, Jan. 16, 1887.

MR. STEELE.—"I do not wish to take too much of your time, but I do want to say a word about this matter. We are very glad to hear from Mr. Sherman, who perhaps ought to be called the father of this Society, as he was the prime mover in it, and we have not heard from him in a long time, but I must say I think his paper bears a little too hard on the Auditor General. I think the Auditor General is not to blame for the present law, and do not think he wants the duty imposed on him which is done by the present law. He has plenty to do without it. But I do submit that since the plats have been sent to that office, the platting of villages and the recording of these plats has greatly improved. Now, I was one of those who brought this about, to have some system for inspection of town plats. We found that plats were made of all descriptions, kinds of paper and sizes. Every conceivable daub that men could get up was called a plat. They were tucked here and there, wherever they could be got out of the way, at the State House and at the Registers' offices throughout the state. I know of one Register who undertook to record a plat by drawing it across the two pages of the book, and you may imagine what kind of a pretty thing he made in there, and then tipped some ink on it to fix it nice. That was the system we had years ago. We have improved some since then. We require plats to be made in some specific way, and have a system of inspection and approval of it. Perhaps it is carried too far. Perhaps the law gives too much authority to the Auditor General. I am not prepared to say but what it does, but still we have made a great advance."

MR. SKEELS.—"The Auditor General should not be blamed for work that has been forced upon him by the act of the Legislature, though I admit that it is very annoying and is not generally our fault, for they make almost semi-monthly changes in their circular of instructions. The one sent out about the 28th of September had a resolution from this body that monuments should be placed so and so. I think that is a detriment to the efficiency of the plat. Most of my work is platting. I make thirty or forty a year. In one case a party was in a great hurry to get his plats accepted, and he had to set the monuments and some of them were graded out right away. Still we certified that we had set them. It frequently occurs where these monuments are set, there will be a cut of several feet, and it is not best to set them there. If we could set the monuments at the corner of the grounds and at other points, it would do; but to set them at the intersections of all streets, and of streets and alleys, is asking considerable. We must add to that monuments at all angles of the plat, and angles of streets and alleys."

MR. APPLETON.—"The Auditor General does not see these plats. If I had thought there would be any such discussion as this I would have brought along a plat to show you how it was treated in his office. I hope the law will never be amended that requires monuments to be set at every angle. Do what you will with the intersections, but I hope the monuments at the angles will be kept. We have a street in Lansing that angles from Michigan Avenue. You cannot locate that angle and make your work agree with the plat. I have almost begged the contractors to let some of our street monuments be till I could get time to lower them, but before I could get there the men had torn them out. It was very important that they should be saved, as land was valuable and a great deal depending on them."

MR. HODGMAN.—"I think there is a question as to the location of the monuments at street intersections that is an important one. Shall they be placed at the intersections of the centre lines, of the side lines, or at some intermediate point? Where is the best place for them? In a plat that I sent in, they were planted at the corners of blocks, and no objection was made at the Auditor's office on that score. The monument is really the most important thing in the survey. If you do not make your monuments so that any surveyor at any time can find just where you run your lines, your work is almost lost. There is trouble in every city and village of my acquaintance, which has reached any considerable size, on account of street lines, and it all arises from the want of proper monuments to locate them by. If monuments had been set in all these places in the manner contemplated by the present law, and they had been properly preserved, all this trouble would have been avoided. The public, as a public, would find it cheaper, in the long run, to pay ten times the cost of setting and preserving these monuments, than to let it go undone.

If there are such cases as Mr. Skeels mentions, we do not want to say we will not have the monument, but rather say let us have that monument taken care of.

"Now, a few words in regard to the inspection of plats. As Mr. Appleton says, the Auditor General does not do it. It is done by a deputy or clerk in the office, usually by Mr. Pratt. I fully believe that he intends to do just what is right, but he is neither a surveyor nor a lawyer, and I think he errs woefully in some of his rulings. If Mr. Pratt is busy, or happens to be out, Mr. Bartholomew is called on, and this tends to mix things, as for instance: Last summer I made a plat, just before the new law took effect. Knowing that the new law would be in effect before it could be recorded, I made it in accordance with the new law, leaving out the surveyor's acknowledgment, and in its stead putting in the surveyor's certificate as to the correctness of the plat, location of monuments, etc. I had to send it to Illinois for the signature of the owners, and the certificate of the Clerk of the Court that it was executed in accordance with the laws of that state. This certificate was made on a printed blank, filled out in the usual form, and was pasted on the plat. When complete I took it in person to the Auditor General's office. Mr. Pratt was away, and Mr. Bartholomew was called in. He objected that I had not acknowledged the plat, and that the certificate was pasted on. I said: 'There is nothing in the law *requiring* the surveyor to acknowledge it, and never was. That is only a requirement of this office, and as the only thing in the law which even hinted at such a thing has been repealed, which repeal will go into effect before this plat can be recorded, you ought not to reject it on that account. As to the certificate being pasted on, that is no affair of yours. This plat does not go into your office, nor the Register's office to stay. The copies which go into these offices will both have this certificate copied onto the plat itself. It is no concern of yours if the certificate does get torn off from the original.' But he could not see it in that light. The plat must be made out in accordance with laws and instructions in force at the time it was signed, no matter when it came for approval, and the certificate must not be pasted on. So I sent the plat back to Illinois to have the clerk's certificate put on the body of the plat. Then I put on an acknowledgment saying that I made that plat and I acknowledge that to be my free act and deed. I had it duly attested by the notary, and took the plat back. Before I got to Lansing the new law was in effect, and so was Mr. Pratt. He said: 'This won't do. I have sent out circulars calling attention to the change in the law, and here you have got on an acknowledgment by the surveyor, which ought not to be there. I cannot approve such a plat as that.' But he *did*, very reluctantly, and after considerable argument.

"In this plat the monuments were planted at the corners of the blocks. It is very important that these monuments be placed where they are the easiest of access and least likely to be disturbed. I think we ought to

agree among ourselves as to what to use for monuments, and where to place them for streets, and make all our work as good and as uniform as the varied circumstances will permit."

MR. STRONG.—"I am not disappointed in Mr. Sherman's paper as the gentleman from Grand Rapids is. It hits me exactly. If I said what I think, the language would be stronger than Mr. Sherman's, so I will skip it. There is probably not one of us who wants one monument less than is required. I believe it is all right to plant all that the law directs, and it is immaterial whether they are in the centre or on the side of the streets, only we ought to agree on it for ourselves, if the Auditor General does not tell us where to put them."

MR. STEELE.—"Suppose a plat is laid out. You commence at some well known point and take a line for a base from which you measure all the angles at every point, and you put all important angles or bearings on the plat and mark down all the distances. Then your plat will show you the relation of every point with every other point on that plat. Now, the point I wish to make is this, that it is not the setting of one corner monument that is important, but it is the placing of a series of related monuments, and you see at once that the more you place the better. Hence I say place more monuments instead of less. Place them everywhere, no matter whether at the intersection of streets, at the side lines, or centre lines, or any other lines. I do not think the position material. The difficulty with monuments is, that you cannot place anything in the ground but what somebody can take it out just as easily. Perhaps a dynamite stake would be a good thing. I wish some of those contractors had one suitably situated sometime. But you have got that contractor right by the throat when you have twenty stakes that are so related that you can replace any one of them that happens to be taken out, by the others. It is not a question whether it shall be a great iron shaft. A good cedar or oak post, well planted, will have a preservative force of say thirty years. I do not know how much longer. Put down all the stakes you can. Plant them in exact relation one to another, and you have got a splendidly monumented plat. Put the bearing on every line. Put the angle at every intersection. Put the stake down everywhere. Put it on your plat, and the more you have the better. Do not leave anything to guess at. Have it so plain that a man who never knew anything about that ground can go there and find the points. We have left too much off. We supposed that the man who came after us knew as much about the ground as we did, which of course is not true, and we want to learn to put on more instead of less."

MR. TEED.—"I do not think it makes any practical difference where a monument is placed, provided it is in the same place in the ground that it is on the map. We do not always find it so. I place them where I find it most convenient, no matter where. It is easier to drive a stake in the

ground and find just where it is, than it is to drive it just where you want it. Having two stakes set out, it is easier to find the true point than it is to find a monument there. In putting down monuments in paved or graveled streets, or where teams are traveling, if it is very difficult to work, I find I can put down two points and exactly record them in less time than a monument in the centre."

MR. STRONG.—"The last plat I made I set over two hundred iron stakes, one at every corner of a lot, and in addition to the iron there was a large wooden stake. With one-half inch iron you can iron up a plat splendidly, and make much better stakes than you can out of wood or in any other way. In making plats I do not make one for the original and wait before making the others. I make the whole lot and clear up the table."

MR. SKEELS.—"We have to make four maps, or copies, and I do not make them all at once. I lay them all in a pile and prick them through, and finish up the copies after the original is approved. I take the precaution to ask the Auditor General to correct a small error. I had something to say on monuments, but our worthy President has covered the ground, with the exception of location and material. The party that made the stakes for Mr. Strong was not well acquainted with the boys. If, instead of sharpening them, he had put a big head on, they would have lasted longer. The object of setting a monument is to plant something that will be lasting. What shall we use? I drive stakes of white oak from twelve to fifteen inches long. The particular location does not matter, but still I think there should be a certain method, and all placed at a certain point; and, if impossible to put them there, to note the location and reasons for the change."

MR. HODGMAN. - "It would be better to have the plats examined at the Land Office, and the duplicates kept there. I was in Lansing when the bills amending the law were pending. I talked with Mr. Pratt relative to the examination of plats, and he said: 'This work has been placed upon our office without consulting us. We get nothing for it. We do not like to do it. I do this work to the best of my knowledge and ability, but I wish I did not have it to do.' I then talked with the Deputy Commissioner of the Land Office, Mr. Sleeper, and he said it could be attended to in his office without any trouble, as they kept skilled men in such work constantly employed, and it seemed the proper place for it. The bills on the subject were consolidated into one by the House Committee, and provided for the examination of plats in the Land Office. In that way it passed the House and was favorably reported in the Senate. Later our representative, Mr. Kirby, informed me it had been changed back to the Auditor's Office at the instance of the City Engineer of Lansing. It was not the City Engineer, though, but another man who wanted to keep a job, who got the bill changed."

PRESIDENT STEELE.—"Before closing for dinner I wish to call attention to another matter. Last summer I sent out circulars asking each member to give us some little item of experience. Now I want each one of you to do so, in as few words as possible, and put your name to it. To illustrate what I mean: I was out with the engineers running line for a railroad and they lost the handle to their tape. When I got up to the house I took a piece of hard wood and made a conical hole through it large enough to admit the tape at the small end of the hole, put the tape in and fastened with wedges, for a handle. It was about the size and shape of a hen's egg, and worked to a charm. It would slip along through the brush without catching, and a man could pick it up readily. Afterward the tape was broken and I used the same device to mend it. I put the two ends together carefully, drove in the wedges, and two men could not pull them apart.

"Another: I went up to Elk Rapids to execute a plat and set the stakes, and they had not got a sharp axe in the party. So I said, 'Take these cedar blocks down to the shop, split them up, and have them turned.' It was the nicest thing I ever struck. In a little while the fellow came back with all I wanted and twice over. They were about two inches in diameter and sharpened very true, and are driven very easily and exactly.

"I want fifty of these little jottings to go into our report. Give the Secretary something before we dismiss."

MR. SKEELS.—"Mr. Wm. Thornton, a member of this society, died yesterday at one o'clock, at his residence in Grand Rapids."

MR. STEELE.—"Mr. Thornton is well known, and this should receive attention. It is now twelve o'clock, and it will be well to refer it to a committee."

MR. HODGMAN.—"Aside from the deaths of our members noticed in our last report, I have learned incidentally of the deaths of Messrs. R. E. Williams, of Jackson and C. M. C. Snover. Both were men well known in the profession, and I would move that a committee be appointed to prepare notices of our deceased members." Carried.

PRESIDENT STEELE.—"I appoint as that committee C. E. Greene, H. C. Pearsons and Dorr Skeels."

Adjourned.

WEDNESDAY, 2 P. M.

MR. STEELE.—"Our first paper this afternoon is on 'Map Drawing,' by Prof. Denison. I am very glad of this favor, and to hear from him on the subject."

Map Drawing and Lettering.

Mr. President and Gentlemen: When invited by your Committee and Secretary to read a paper before this Society upon "Map Drawing and Lettering," I was guilty of the very common folly of a too generous estimate of the time and opportunities at my command, and now find myself embarrassed by the inadequate and hasty treatment, which, owing to an unusual pressure of duties, I am obliged to give the subject. I must, therefore, gentlemen, beg your most considerate indulgence.

A further source of embarrassment is the exchange of an audience of students taking their earliest steps in the topographical art, for one composed of experienced practitioners, many of whom have attained distinction in the profession, and all whom it may fairly be presumed stand in no need of aid or advice from me.

Permit me in the outset to disavow any claim to originality in this paper. There are no new problems to show, nor any new and striking methods for the solution of old ones, and I give you simply the results of my own thought and experience, and at the same time levy tribute upon any source of information within my reach which may be of service.

Without entering too minutely into detail, let us briefly consider the materials to be used, their quality and adaptability to the purpose in hand, and first, as to

Paper.—The essential quality of a paper for map drawing is a hard, firm surface of uniform texture, which will take ink or water color smoothly and readily, and which is sufficiently tough to bear the use of instruments and rubber without sensible injury to its surface. Perhaps no paper fulfills these requirements better than *Whatman's*, and comes in sheets of various sizes up to "Antiquarian," 31 x 53 inches. These papers are either *hot* or *cold* pressed, the former with a fine, smooth surface, particularly adapted for pen work; the latter has a somewhat coarse-grained surface, and is more especially designed for water color drawing, or plats on which the brush is to be used more or less. Of course there is a large variety of paper, and for various purposes, but within the limits of the size above given, it would be difficult to find anything superior to the product of "Whatman's Turkey Mills," which words can usually be read in water-line on each sheet. This paper also improves with age, and an old stock is consequently rather more valuable.

Probably the best *pens* for mapping purposes are *Gillott's*. His lithographic pen, mapping pen, and crow-quill, are all valuable in the free-hand work, but generally for ordinary use his writing pen No. 303 will be found very serviceable, while for filling in the bodies of letters of moderate size, nothing is more useful than a common stub-pen, though some draughtsmen prefer a regular old goose-quill.

It is well to be somewhat critical in the matter of *inks*. There are a

number of brands of liquid ink on the market, some of which are good, some admirable for special purposes, but after all no sufficient substitute can be found for the best quality of India ink, and when ground with a few drops of water, on a Keuffel & Esser ink slab, the time occupied is so slight that it is more than compensated by the satisfaction experienced in its use. Most emphatically India ink should be of a fine quality, and as a rule the higher the price the better the ink. True economy would pronounce in favor of an expensive cake, a fragment of which would last a draughtsman through the natural term of an active professional life. The best ink works up smoothly with water, forming a perfectly black mixture, and after drying upon the paper forms a fine, glossy surface. For use it should be *just black*, as pale ink will make the boldest drawing look weak, and on the other hand, if too thick, it will constantly annoy the draughtsman by clogging the pen. After once grinding up a quantity of ink, a drop or two of pure glycerine will prevent its drying away for some time, and does not injure the mixture. If it is preferred, a liquid ink can be prepared by pulverizing a portion of the cake, and boiling it in a small quantity of water till the proper consistency is reached. It can then be kept in a vial and used as desired. Such a preparation, however, is apt to become offensive in the course of a week or two, and should then be re-boiled after the addition of fresh water. A common test-tube is the best vessel in which to make the solution. After grinding ink from a cake of fine quality, it is well always to wipe it off carefully with a soft cloth, as this prevents waste by cracking and consequent disintegration of the cake.

As to *instruments* for map-drawing, in addition, of course, to drawing-board, T square and triangle, but few are needed — but these few should be of good, not to say of the best quality — and ought to consist in general of at least one large *right-line* pen, for drawing heavy lines, such as borders; one small *right-line* pen, for the finer lines; a pair of *spacing dividers*, and a large pair of dividers, with pen, pencil and needle-points. These instruments should be kept in perfect condition, or they cannot be made to do good work. The pens should be frequently sharpened by gently passing the outer surfaces of the blades over a fine-grained stone, used dry. A fine knife-edged stone is sometimes applied to the inner surfaces, but this must be done with great care. When properly sharpened the points will be exactly even, and sharp enough to make, with slight pressure, a fine cut on the finger nail. A magnifying glass will aid in determining when the points are smooth and even. The best test, however, is to fill the pen and draw a series of lines, when, if they are all sharp, and clear and unbroken, the pen is in good condition. The best implement for charging a drawing-pen with ink is a common quill toothpick, using the long pointed end.

Having touched briefly upon the materials used by the draughtsman in his work, let us now consider somewhat more carefully, manner and

methods of execution. And here let me say that, as other and abler hands have in charge the elucidation before this meeting of general and special problems relating to the actual operations of platting and constructing the map proper, I am permitted to confine myself to what we may perhaps call the artistic or finished appearance of the work.

While no one will gainsay the fact that the first and supreme requirement in a map is accuracy, or correctness, that quality of reliability without which it is not what it pretends to be — a map — nevertheless there are other qualities which it is by no means wise or judicious to neglect.

Among these may be mentioned clearness, precision, legibility, neatness and sharpness of execution. and a certain prepossessing appearance which inspires the observer with confidence in the skill and powers of the maker. In fact, no map, or technical drawing, is above suspicion, or safe from the shadow of a doubt, when it bears upon its face traces of weakness which mark a want of knowledge and ability even in so simple a matter as, for instance, the form and proportions of the letters of the alphabet.

Furthermore, as a map or plan addresses itself directly to the eye as a product of skilled labor in one department of the art of design. it is not only right and proper, but essential to its complete success, that it should produce a pleasing impression, satisfying the demands of good taste, which can only be the result of the proper application of the laws of design.

We may pretty safely assume that the demands of a cultivated taste will be met by a reasonably close adherence to the following simple principles: First — Construction may be decorated, but decoration should never be purposely and obviously the object of such construction. Second — Generally ornamentation should be based upon geometrical construction, and should make no attempt at relief or pictorial representation, and "natural objects should not be used as ornament, but conventional representations founded upon them, sufficiently suggestive to convey the intended image to the mind, without destroying the unity of the object they are employed to decorate." Third — "Harmony of form consists in the proper balancing and contrast of the straight, the inclined, and the curved." These are fundamental propositions from one of the highest authorities on decorative design. While these principles are safe guides, and doubtless there are powerful motives for the introduction and use of geometrical forms for decorative purposes, founded upon their inherent beauty and almost universal employment, still if any authority can be claimed for precedent, custom seems to have sanctioned the use for map decoration, to a limited extent, of vignettes, free-hand sketches, and symbolic devices, as are sometimes seen in finely executed work, wrought into the corner-piece or into the title. In fact, the value of a map, as a means of conveying information of a topographical nature, may

often be greatly enhanced, especially to the non-professional eye, by fine pen-and-ink sketches in perspective of portions of scenery or objects of special interest. But these, to be admissible, must be executed with that spirit and decision which mark the eye and hand of an artist. Of course there are maps, and maps, and the foregoing remarks are intended to apply mostly to such as are of large dimensions and intended for general inspection. For those of a strictly professional nature, it is safe to say that the less exclusively ornamental work upon them the more satisfactory will their appearance be. The dignity of an almost severe simplicity should pertain to a drawing addressed only to the professional eye, depending for its pleasing effect upon the sharpness and clearness of its execution, the completeness and beauty of the lettering, and its evident fitness to the purpose for which it was made, namely, *business*. This character of work is perfectly illustrated in many of the maps issued from the government departments at Washington, and particularly in the charts of the United States Coast Survey.

Having taken this general glance at the subject, let us enter upon the consideration of the design and execution of the more important features of a properly finished map, and first, if you please, let us examine the *border*. Strictly speaking, this is a purely decorative feature, as its entire omission would not effect the utility of the drawing. Still it aids materially in producing a happy effect, by limiting the eye at once to the consideration of those parts having a distinct claim upon its notice. The border bears a certain relation to the enclosed drawing, and is a sort of tribute or compliment to that which it incloses, and should in general reflect the character of the drawing. Thus a line drawing should have a border of geometrical design, executed with the same material as the drawing itself, and of greater or less complexity, according to the extent and elaborateness of the work enclosed. It may be rectangular, or elliptical, or composed of both right lines or curves, according to the nature of the space enclosed, and the draughtsman should never hesitate to omit or break the border in order to accommodate some projecting point or small portion of the plat with which its continuance would interfere. Should the drawing contain much free-hand work, the border might with propriety be partly free-hand also, but free-hand decorations represent, ing garlands, vines, tassels, etc., and all rambling, sprawling decoration- is always weak and in wretched taste. In all map drawing color should be rigidly excluded from the border, as it gives a cheap and offensive conspicuousness to a subordinate feature. The most appropriate border for a map of moderate dimensions, and the one generally adopted by the best practice, consists simply of two lines, one heavy and the other, or inner one, light, with a white space between them about as wide as the heavy black line. The rule commonly followed is to make the total width of the border about the one-hundredth part of the shortest side of the map, supposing it to be a rectangle.

The next feature of a rightly constructed map, and one which is by no means simply decorative, but of very great practical importance, is the *meridian*. A true meridian is a necessary adjunct of all rightly constructed maps, as it is directionally their common line of comparison, and without it no just notion of the situation of the territory represented by the map, or of the bearings of its lines, can be obtained. It is, in fact, one of the co-ordinates to which reference is made for the solution of all problems of position on the drawing, and as such is entitled to consideration. This line should, therefore, be a somewhat conspicuous object, and the object of its existence demands that it should not be so obscured by ornament as to defeat its use as a sharp, clear line of reference for all North and South lines. Nevertheless, the draughtsman is warranted in giving to its construction more than a hasty or careless consideration. It is usual to ornament the northern end of this meridian with some neatly drawn and characteristic device, such as an arrow-head, a *fleur-de-lis*, the head of a mediæval lance, etc. At its southern extremity is sometimes placed the feather-end of an arrow or a crescent. Near the middle of the line may be drawn an East and West line, or four or eight pointed star, or radiating lines marking convenient points of graduation of the circle. It is well, also, to draw the magnetic meridian at the time of the survey, through the middle point of the true meridian, and mark the declination. This magnetic meridian should be even less ornamental than the true one, and when both are used it is generally agreed to draw a complete arrow-head on the latter, while the magnetic line is subordinated by giving it only half a head, drawn on the right or left-hand side, as the declination is East or West.

The construction of a meridian affords considerable opportunity for the display of skill and taste in the draughtsman. It may easily be made an attractive, simple and elegant feature, reflecting the intelligence and spirit of an accomplished workman; or, by its awkward design and slovenly execution, shake one's confidence in the mental capacity of one upon whom we should have a right to rely. Perhaps it would not be inappropriate to say that the meridian line should be sufficiently long, on most maps, to serve conveniently the purpose of transferring its direction to other parts of the drawing by means of a triangle and straight-edge. The arrow-head at the vertex should be a sharply pointed figure, entirely different from the obtuse, nondescript object which too often offends the eye in that position. And, to avoid all possibility of mistake, it is well to place the letter N some slight distance above or below the arrow-point. When a star is used to give the various points of the compass, its radiating arms should be narrow and slender, with sharp points, avoiding all appearance or suggestion of dullness. In short, the entire figure should be constructed in the spirit of lightness and radiation, in harmony with its office, which is simply that of indicating *direction*.

Of course it is entirely unnecessary to state that no map is complete,

or prepared to accomplish the end and aim of its existence, without a *scale*; and it is equally unnecessary to enter upon the discussion of the matter of scales, their construction, uses, and relative merits before this Society. The scale is here mentioned merely for the purpose of directing attention to its paramount importance as furnishing one of the co-ordinates of a map. What is said later, with reference to the title, applies equally to the treatment of scales.

In no department of his work is the responsibility of the draughtsman greater, both in the matter of correctness of detail and beauty of appearance, than in that of *lettering*. Nothing more readily and strongly recommends a drawing to a favorable consideration than an appropriate and handsome style of lettering; while, if poor, weak, uncertain, and badly executed, it is apt to at once arouse in the mind an uncomfortable feeling of distrust and aversion, which surely detracts from the artistic value which the finished work should possess.

There is a certain undefinable pleasure, a mental gratification, which we experience in looking upon anything *well done*; and this is particularly the case with all lettering upon maps, charts, and drawings, as it conveys to the mind not only the sense of the words written, but beyond this there is indicated something of the mental character and practical experience of him to whom the work is due. If it be strong, free and graceful in style, and sharp and clean in execution, it at once commands our confidence and respect, and saves us continual annoyance and waste of time in the endeavor to decipher some blurred or illegible letter or figure, the failure to do which may put one to great inconvenience or delay. Thus, perhaps more than anything else, the lettering reflects the distinguishing qualities of the maker, and should be of such a nature as to clearly indicate a man completely and easily up to his work.

Our alphabet is composed of a certain number of distinct characters, or letters, and we also have certain additional characters for expressing numbers. It is not the purpose of this paper to trace the origin and development of these characters, their evolution, or history; it is sufficient to say that, so far as we are concerned now, they are arbitrary signs which we are bound to adopt and follow. This is true, however, only as to their *essential elements*. Preserving these in their integrity, we are at liberty to alter and modify form and proportion very largely, according to individual fancy. By *essential elements* are meant those lines which are necessary to the recognition of the letter. Thus, every capital A, whatever else it may have, must have the three right-line elements which characterize it in its most simple form.

If one examines a book of specimen letters he may conclude, from the bewildering variety of alphabets, that they are absolutely dissimilar, and subject to no system or order of classification. A little closer inspection, however, will reveal the fact that each letter of these alphabets, which apparently differ so widely, is constructed upon the common character-

istic elements of that letter, a sufficient acquaintance with which, and their methods of variation, will enable one readily to design with consistency and uniformity the letters of any style of alphabet, which gives a most desirable independence of the mere devotion to copy.

Probably the most difficult letter to draw accurately and properly is the Roman, from which as a model we derive most if not all the alphabets now in use. This being so, possibly it will be well to enter somewhat minutely into the discussion of its construction. Let us not, even here, entirely abandon our independence of judgment, but bear in mind that this style of letter in its present beauty of development is simply the resultant of the taste and practice of centuries; and that, while it is generally accepted as a standard, authorities differ as to its exact proportions and minor details which relieves it from the undesirable rigidity of precise rule.

Let us then, if you please, examine the Roman capitals, and my only apology for entering into these perhaps wearisome minutiæ is the hope they may possibly aid in simplifying the construction of this most desirable letter for unpracticed hands. We can separate this alphabet into three groups. Let the first embrace all letters whose essential elements are either horizontal or vertical right lines, such as I, E and H, six letters in all. The second group contains all letters having oblique right line elements, as A, W, X and Y — nine; and the third group will comprise all letters into which curved elements enter, such as P, R, S, etc., eleven in number. An examination of one or two members of each group will be sufficient for our purpose.

Let us take I, for instance, and by assigning it the proportions given in a set of letters designed by Prof. Warren, we make its height equal unity, its width one-fourth the height; the caps at top and bottom project beyond the body of the letter a distance equal to half the width of the column of the letter. The complete proportions would then be: Heighth, unity; width of column, four-sixteenths; total width, including caps, eight-sixteenths; projection of caps, two-sixteenths; thickness of cap, one-sixteenth. These proportions to be preserved in all vertical columns of all letters. The letter L consists of an I with the addition of the arm at the bottom; this arm is seven-sixteenths in heighth, and the total width of the letter is fourteen-sixteenths. From these proportions the first group can readily be drawn.

In the second group we meet with inclined elements, both heavy and light. Let it be noticed that in all letters having slanting heavy elements, with the exception of Z, all heavy elements slant downward to the *right*, and that these elements are four-sixteenths perpendicular width; and all light elements have the same width as the caps, namely, one-sixteenth. By properly proportioning the total widths of the letters, those of this section can be easily constructed. Observe that N is never drawn with a cap at the lower right-hand corner.

In the third group, the widest part of curved elements equals the thickness of the columns, and the narrowest part equals the thickness of a cap.

The letter just described is rather too heavy in its appearance, and would be much improved by reducing the width of all heavy elements to one-sixth of the total heighth, even one-seventh being sometimes used.

The following table, taken from the last edition of Lieut. Smith's Topographical Drawing, will serve as a guide in proportioning capital letters:

"Taking the extreme width of H, measured across the middle, or exclusive of the caps, as the unit, the widths of the other letters, or of their characteristic parts, may be expressed approximately by the numbers in the third column of the table. In case of letters having oblique lines, these widths are to be taken at the intersections of the outer oblique lines with the upper or lower limit of each letter. The caps are in all cases excluded."

LETTER	MEASURED AT	H=I	LETTER	MEASURED AT	H=I
A	Bottom.	$1\frac{1}{16}$	N	– – –	$\frac{7}{8}$
B	Top.	$\frac{15}{16}$	O	Middle.	$1\frac{1}{8}$
	Bottom.	1	P	Top.	$\frac{15}{16}$
C	Top.	1	Q	Middle.	$1\frac{1}{8}$
	Bottom.	$1\frac{1}{16}$	R	Top.	$\frac{15}{16}$
D	Middle.	$1\frac{1}{16}$		Bottom. *	$\frac{15}{16}$
E	Top.	$\frac{15}{16}$	S	Top.	$\frac{15}{16}$
	Middle.	$\frac{9}{8}$		Bottom.	1
	Bottom.	1	T	Top.	$1\frac{1}{16}$
F	Top.	$\frac{15}{16}$	U	– – –	$\frac{7}{8}$
	Middle.	$\frac{9}{8}$	V	Top.	$\frac{15}{16}$
G	Top. *	1	W	Top.	$1\frac{1}{8}$
	Bottom.	$1\frac{1}{16}$	X	Top.	$\frac{15}{16}$
J	Bottom.	$\frac{3}{4}$		Bottom.	$1\frac{3}{16}$
K	Top.	$\frac{15}{16}$	Y	Top.	$\frac{15}{16}$
	Bottom.	$1\frac{1}{16}$	Z	Top.	$\frac{15}{16}$
L	Bottom.	1		Bottom.	1
M	– – –	$1\frac{3}{16}$			

*Measurement is from vertical tangent to the curve.

The horizontal bars of H, E and F are at the middle of each letter; those of B, P and R are very slightly above it; while the horizontal bar of A is from one-eighth to one-sixth the heighth of the letter below the middle. It improves the appearance of the E, C, G and S to make the lower half a trifle wider than the upper, as is indicated by the proportions given in the table, and the ends of the arms of these letters should come nearly together, the extremities of the S being nearly on a horizontal line.

Of course no practical draughtsman, engaged in his work, stops to pay attention to these refinements of proportion. They serve simply as

guides to the inexperienced, and should be employed only in the study of the letter on a large scale. Letters of the size ordinarily employed should be proportioned by the eye, and sketched in free-hand in pencil and afterward inked in, instrumentally if preferred. In drawing the small Roman letters, the same free-hand practice is required, and they are finally put in by a bold pressure of the pen for the heavy parts; the heighth of the small letters, such as a, e and o, being equal to three-fifths of the heighth of capitals.

The general rule for *spacing* letters, is to make the areas between them approximately equal, and of course these areas are only estimated by the eye.

Having conquered the Roman, other alphabets will offer but few difficulties to the draughtsman. In the order of their importance for mapping purposes the letters are ranked thus: First—the upright Roman CAPITAL; second—the inclined *CAPITAL;* third—Roman, or ordinary small type; fourth—the *small italic*, or *stump print*, to be followed by the block, the skeleton, and an infinite variety of styles, fanciful and otherwise, not forgetting Old English. Inclined letters are usually regulated by a slope of three horizontal to eight vertical, and in the *stub print* the heighth of the smaller letters is three-fifths the heighth of capitals. This stub-print somewhat resembles careful writing with the pen, and with some practice can be done very rapidly and made to present a very neat appearance. It is most perfectly adapted for statements, explanatory notes, etc.* Free-hand random letters, of vigorous and graceful style, may be easily designed, and sometimes relieve a drawing of undue stiffness. Good models in great variety can be easily obtained, and can with profit be carefully studied and practiced.

The adjustment of the heighth of letters to the scale of the map is worth considering, and the following proportions have been suggested by Prof. McMillan, C. E.:

SCALE.	Hight of Largest Upright Capitals.	Hight of Small Letters for Explanitory Notes, Etc.
$\frac{1}{600}$ or 1 inch to 50 feet.	Six-tenths of an in.	Twelve-hundredths of an in.
$\frac{1}{2640}$ or 2 ft. to 1 mile.	Five " " "	Ten " " "
$\frac{1}{5280}$ or 1 ft. to 1 mile.	Four " " "	Eight " " "
$\frac{1}{10560}$ or 4 in. to 1 mile.	Three " " "	Six " " "

The size and character of the letter used depends upon the nature and importance of the object to which it is applied, as capitals to large cities, important bodies of water, etc. On the United States Coast Survey charts upright letters are used for land objects, such as islands, points, etc.; and for bodies of water, rivers, bays, and so on, the inclined letter is employed.

* Fine examples of this letter can be found in a certain interesting statement on the backs of United States "Greenback" notes.

When practicable the lines of lettering should be parallel to the base of the drawing; if the lines incline toward the upper right-hand corner, the letters should be arranged to read from the bottom upward; if they incline from the bottom upward to the left, they should read from the top downward.

The last feature to which I shall venture to direct your attention is the *Title*, the execution of which affords a suitable opportunity for enhancing the beauty of the map by a choice selection of the letters used, an appropriate arrangement of the words, and the indulgence in a fitting amount of ornamentation.

If the title be brief, and takes but a single line, it may be placed outside of and just below the border, otherwise it must be placed within it, its location depending upon the configuration of the map, preferably one of the corners. The letters of the wording are varied in size according to the importance of the words. Their order of prominence is usually determined by answers to the following questions: First — What does the map represent? Second — Where is the locality? Third — For whom have the survey and map been made? Fourth — By whom and when?

The title should be symmetrically arranged, with reference to a middle vertical line, placing the most important words, if possible, about midway between the top and bottom of this arrangement; and the heighth of the letters composing this principal line should not exceed one thirty-third part of the shortest side of the map.

In the case of an elaborate title it is a good plan to make a preliminary drawing, in which alterations can be made in the style and arrangement until the proper effect is produced.

The title is the introduction of the drawing to the observer, and should therefore be marked by a somewhat formal and dignified grace. Anything of the nature of over-decoration should be carefully avoided, and I cannot close this already too extended paper without expressing my cordial antagonism toward the too frequent practice of employing elaborate pen-flourishes, "rustic letters," fluttering ribbons, and numerous devices of a like nature, for map decorations, with the laudable intention, no doubt, of adding enrichment to the drawing, but with the unfortunate results of cheapening the effect and violating good taste."

MR. HODGMAN.—"Before going farther let us attend to a little matter of business. I notice that Mr. Gurley is preparing to leave to-night with his instruments, and as we have no committee on instruments, I move that a committee of three be appointed to examine and report on the exhibit." Carried, and Messrs. H. C. Pearsons, Geo. S. Pierson and M. E. Cooley appointed on the committee.

By PROF. C. E. GREENE—

Highway Bridges, from the Point of View of the Public.

We are all interested in highway bridges, whether we have anything to do with their construction or not. If we are engineers, our interest may be an especially professional and pecuniary one; as a part of the traveling public, we all are concerned with the question whether they are so proportioned and built as to carry us safely and conveniently, and we may feel a moderate interest in their external appearance, preferring that they should harmonize with their surroundings rather than repel by their ugliness. As tax-payers, also, we may have an interest in a particular structure, and may desire that it shall be economical in first cost, in maintenance, and in length of life or usefulness.

That bridge is not necessarily the cheapest, in a correct view of the matter, which has been offered by the lowest; bidder for we must take into account, besides the interest on the capital invested, the cost of annual maintenance and repairs, of renewal, if such renewal becomes necessary in a greater or less length of time, and not unfrequently the pecuniary loss and public inconvenience by interruption of travel during such renewal.

Are the methods generally pursued in obtaining iron highway bridges conducive to the protection of the interests of the tax-payer and to the safety of the traveling public? Such is the subject to which I propose to confine my remarks. Do town authorities or county commissioners take those steps, when contemplating the building of a new bridge, which will insure their obtaining a structure thoroughly safe and substantial, well adapted for the place, and one which, while reasonable in first cost, shall give the community a bridge lasting for a long period and requiring but little repair as time goes on? Have these officials the acquaintance with the subject and the proper technical and expert skill to know what to ask for, and to assure them that they get what they ought to have?

It appears too frequently to have been the case, if we may judge by results, that county commissioners have considered themselves quite competent to handle the problem of a new bridge, or on a penny wise and pound foolish, or save at the spigot and waste at the bung-hole, policy, which so frequently characterizes the conduct of municipal improvements, have trusted themselves in the hands of interested parties

to save a professional fee. Commonly, after they have been swindled or involved in difficulties through the criticisms or investigations of tax-payers or others, they will call for expert advice.

Prof. Geo. L. Vose some years ago published a pamphlet entitled "Bridge Disasters: Their Cause and Remedy," in which with a very caustic pen, he described the evils of the too common mode of obtaining a bridge. Let us quote from it what he says on how "To buy a bad bridge": "To buy a bad bridge—just as soon as your town or county votes money for a new bridge, certain agents [and they are as numerous as the agents for sewing-machines or lightning rods] will call on or write to the town or county officers, and will offer to build anything under heavens you want, of any size, shape or material, and for almost any price. They will produce testimonials from all the town and county officials in the country for the excellence of their bridges, and would not hesitate to give reference even for their moral character, if you should ask it. If they find that you dont know anything about bridges, they will, to save you the trouble, furnish a printed specification, which document will commit you to pay the money, but will not commit the bridge company to do anything at all. When the bridge is put up you never will know whether the iron is good or bad, nor whether the dimensions and proportions are such as to be safe or not. You will know that you have paid your money away, but you will never know what you have got for it until some day when your bridge gets a crowd upon it and breaks down and you have the damage to pay. This mode of buying a bridge is very common."

Another pamphlet, by J. A. L. Waddell, just issued, upon the same subject of highway bridges, describes the ordinary routine of bridge lettings substantially as below; and although the writer knows from what he has seen and heard in his own experience many things confirmatory of the statements, he prefers to give that description here, first citing, as a sample of what is asked for, an advertisement from a recent technical paper:—

"A bridge to be built, —— feet span, 20 ft. roadway, two 5 ft. sidewalks, the whole to carry 80 pounds per square foot, with a factor of safety of four."

Some of the points in this advertisement will be referred to presently. Mr. Waddell says:—

"The ordinary routine of bridge lettings is about as follows:—A few weeks before the letting occurs an advertisement is put in a local paper stating that on a certain day bids will be received for one or more bridges. Generally the spans are given and often the width of roadway. In the rare cases, where expert advice has been taken in advance, the data are reasonably full and to the point.

"On the day of, or the day preceding the letting, from ten to a score of traveling men, some representing bridge companies, but others merely

scalpers, assemble for the purpose of getting as large an amount of money as possible from the commissioners for as light and cheap a bridge as will be accepted. There is usually a secret meeting of the competitors at which it is decided what is the greatest sum they dare ask. If, as is usual before inviting tenders, the commissioners make an appropriation for the work, the bridge men make it their business to ascertain the amount, and it is seldom found to be too small to build some kind of a bridge. By shortening the total length, substituting wood for iron, narrowing the roadway, decreasing the assumed allowable load and increasing the allowable stresses, a design can be made to come within the appropriation, and still leave a little to divide among the bridge men.

"Having decided, first, upon the greatest sum to be obtained (that is, the amount of the lowest bid), the competitors decide, second, what the cheapest acceptable bridge ought to cost, third, who is to have the contract, and fourth, how the estimated profits are to be divided between the successful bidder and the unsuccessful ones. If these four points can be settled amicably, all goes well—but if not, there may be disagreement, in which case the competitors may bid far below the cost of a legitimate structure, and often below that of the cheapest bridge they can erect, merely for the sake of spiting or crowding out some other bidder.

"The formation of a pool may be bad for the county, but this disagreement is much worse. In the first case there is a chance of obtaining a passable structure, but in the second case there is none."

What has been quoted agrees with what the writer has often heard. If a bid for any work is so far from the estimate of more careful and experienced men as to prove that the bidder lacks judgment and experience to realize the character or quantity of the work before him, he should not be allowed to attempt it at all, as the work will inevitably suffer in its character and execution as well as be delayed in completion.

Sometimes commissioners who doubt their capacity to decide everything from their own knowledge, but who wish to economize by employing as little expert assistance as possible, get some engineer to look over the strain sheet to see whether the strains are correctly computed, and perhaps to verify the sections of the various members by the assumptions which they may have decided upon or the bidder may have tendered. If done before the bridge is built, deficiences may be corrected; but if put off until after the completion of the bridge, as I have known it to be, the result is usually a compromise, a slight patching up of some parts or a little discount from the contract price to make a settlement.

How does any commisioner know whether he gets good iron, or bad, imperfectly worked, hot or cold short, unless it was inspected? One favorite device of dishonest contractors is to order, from the mill, iron of lighter or thinner sections than are shown on the drawing or strain sheet, which cannot be detected without careful calipering, as the external di-

mensions are practically unchanged. This is known as "skinning the bridge." [Specimens exhibited.]

Do county commissioners and town authorities know what kind of a bridge they ought to have, and do they get what they ask for, even if they ask for the right thing?

Do they get the material they should?

The ability of iron to withstand the strains to which it is subjected in a bridge depends not only upon the strength, but upon the amount of deformation, elongation or compression which will be produced by a given force. The elastic limit and not the ultimate strength should be the measure of the stress allowed, and that quality of iron for which the product of the working stress or force applied and the elastic elongation produced by it is a maximum, will be the best to resist shocks and vibration (for this product is a measure of the ability of the material to do work or absorb energy), and not that iron with high elastic limit alone, much less high ultimate strength and little ductility. The iron should be thoroughly worked, so as to be homogeneous and what may be popularly termed tough as distinguished from brittle. The sample herewith, which on its exterior gives little or no indication of its internal structure, and which I brought from a bridge works where it was being made up into bridge parts, shows on the fractured section the great lack of uniformity and of the work that should have been done on it.

The safe load which a structure or piece should carry depends not only upon the proportion which the safe load bears to the breaking load but on the number of times the load is to be applied and released. Hence, a roof truss may carry safely a greater intensity of stress than can a bridge, and a large bridge, receiving its maximum load less frequently and less quickly than a small structure, may very properly be designed with a somewhat larger intensity of stress in those members which receive the maximum stress from a full load only. A structure which will be loaded to its maximum but a very few times may therefore be safely strained more heavily.

One sometimes wonders that the self-interest of a contractor does not force him to build a strong bridge; for it would be supposed that the failure of a structure would be damaging to his business. It seems probable, however, that he counts upon the chance that the maximum proposed load will seldom or never come upon the bridge; and, indeed, members which are strained once or a few times very considerably beyond the elastic limit, or even well toward the point of rupture, will not fail then, although they may afterwards give way under a smaller load, while the ultimate break-down is only a question of time. If, from infrequency of maximum loading, the structure stands for a few or several years the contractor will be out of the way, or retired from business, or will lay the failure to abuse of the bridge or neglect by others.

Hence, also, we can readily see why it is that a bridge builder is very willing to subject his bridge to a test load of the required amount, and to point to the result of such test as a convincing proof of the excellent character of the structure,—a proof which most people, not experts, will be entirely ready to accept. But the endurance of such a test, once applied, or even repeated, is no evidence that the structure is well designed and adapted to such a load, for it may have been seriously injured by the strain and give no sign, but be ready to fall without warning on some other occasion from an apparently trifling cause. Every poor, worn-out bridge has already practically endured such a test. When we read that a bridge across a canal in Lafayette, Ind., fell with 30 head of cattle on it; one in Iowa, of 160 ft. span, fell under a herd of cattle; one in Kansas fell down under a road scraper drawn by six horses; some have fallen under single teams or ordinary highway travel, and others under little or no moving load at all, we know that such structures have previously borne greater loads, and that all bridges ought to be so designed in every member, detail and joint that, with reasonable care, they should carry the maximum possible moving load, in addition to their own weight, snow and wind pressure, with entire safety for a long term of years, if not indefinitely.

What is meant by the factor of safety of four, previously mentioned, and not infrequently proposed by highway bridge builders? It is assumed to be the number of times that the load just large enough to break a piece or a structure by a single application exceeds the actual maximum working load. Hence, if the iron is supposed to have 50,000 lbs. per square inch tensile strength, a factor of four would mean that the pieces might be designed for 12,500 lbs. per square inch under the maximum working load. If 45,000 lb. iron is used and called 50,000 lb. iron, what then?

If the bidder should pretend, as has sometimes been done, that his iron was equal to 60,000 lbs. breaking strength, such a specification would allow him to figure on a strain of 15,000 lbs. per square inch.

All such views as to ratio between safe load and breaking load are entirely erroneous, unless possibly the repetitions of load are to be extremely few. The elastic limit is that amount of stress at which permanent deformation first becomes apparent, and when the elastic limit is exceeded in repetitions of stress the ultimate failure is only a question of time. Hence the ratio of the elastic limit to the allowed strain is the true factor of safety in the ordinary use of a structure.

Do these officials get the *workmanship* they should?

Can they tell or not as to the fitting of parts and the arrangement of joints, so that the stress may be uniformly distributed over the cross-section of a piece, and not greatly increased in intensity by badly designed and unsymmetrical attachments, or ill-fitting connections and

careless workmanship, causing the line of force through the member to lie to one side of its axis? A little deviation of this kind may weaken a piece by a very large percentage.

It is of no avail to build a bridge with the proper sections in its various main members, if the connections, joints and all the details are not equally well adapted to the forces brought to bear upon them. A weak part is as bad as a weak member. A self-evident rule, often overlooked, is to make the joints and connections, as nearly as possible, as strong as the pieces they connect. One not possessed of a good knowledge of design cannot understand how serious a matter a slight difference in arrangement of parts at a joint, or maladjustment of bearing may be. The weakest link in a chain determines its strength as a whole; the failure of an ill-designed hanger at one end of a floor-beam was undoubtedly the cause of the recent bridge disaster near Boston, on the Boston & Providence Railroad.

It is not worth while now to do more than to allude to the great increase in stress which may be caused by assembling several pieces at a joint so that their centre lines do not intersect at a common point. Grave errors are not infrequent from this cause, especially in riveted work. Of such matters only an expert is able to judge, and bad workmanship must be looked out for and prevented at the place of manufacture. Some of it cannot be detected after the bridge is up, and then most of it is beyond remedy. A liberal use of paint, and perhaps putty, will cover open joints, hide flaws, and to some extent fix loose rivets.

It is not sufficient to proportion a bridge for a load which may be on a par with the traffic of the present day, if, from its location in or near a growing town, there is a likelihood of a decided increase in its loading before a fraction only of what may be considered its reasonable time of duration has passed. To cite the case of a bridge in a flourishing western city, erected in 1870: On it has been placed a horse-car track, a ten inch water main, and worst of all, two lines of telegraph poles, secured to the trusses, and each carrying from 15 to 20 wires. The travel over this bridge (span 150 ft., height at middle 15½) is very heavy, and while it ought to be adapted to carry 100 lbs. moving load per square foot, its top chord is proportioned for 25 lbs. only of moving load in addition to the weight now on the bridge and the remainder of the truss is much weaker, indeed the bottom cord consists only of 9—6x¾ (equal 2 sq. in.) inch bars on edge, carrying the floor joists directly on them, in a panel of 12 feet, and drawn down to rods 1⅛ in. diameter, or 4.15 sq. in. at the ends.

Those bridges which are contracted for by bidders who have no works of their own, and which are let out to some shop to be built by the pound, need especial oversight during construction. The actual builder has no reputation at stake in them, for he simply fashions and puts together materials according to plans furnished him, and he does not

appear in the business at all; and the contractor often has no standing or reputation to lose. Any kind of iron, so long as it is cheap, any section that will satisfy the outside dimensions given, any workmanship that will make parts go together, is good enough. So poor iron, thin sections, sledge-hammer and drift-pin work go together to make a poor bridge.

On once visiting a bridge works, to see their facilities and their preparations for beginning work on an iron bridge on which they held a contract, the writer saw some shape iron mauled with the sledge hammer. On remarking on such treatment of material, he was told in effect, "Oh, that's not any of your work; that is sub-let work we are doing for another man on his own design; we don't treat our own work so." In another part of the shop some more of the same job was seen forced to go together by the driving of drift-pins in the rivet holes to make them coincide. Again the writer was informed that those pieces belonged to that other outside job, and that his work would not receive such treatment. A resident inspector at the works and another at the rolling mill will insure good work.

What bridges do we get under the lack of intelligent foresight and oversight? A recent number of the *Railroad Gazette* says:

"A few years since an iron highway bridge was built in one of the Middle States, which was guaranteed by the makers to carry safely a moving load of 2,240 lbs. per running foot. Such a load would have strained the iron in some parts of the work to 56,000 lbs. per square inch in tension. The weight of the bridge alone kept 15,000 lbs. per square inch on iron which was of the most inferior quality. The bridge having been condemned, after a long controversy, was removed and replaced by a better one. The condemned bridge was afterwards again sold by its original builders, without any alteration whatever, and guaranteed by the company to carry safely a moving load of 3,000 lbs. per running foot. Again, it chanced that one of the most disreputable concerns in the United States underbid all other competitors, and, somewhat to its own astonishment, secured the contract for a large city bridge. The work had to be done according to the plans and specifications and under the inspection of the City Engineer. The result was a considerable loss to the contractor, who made the remark, after the bridge was finished, that it would take at least ten good highway jobs to make him whole."

"One company has not hesitated to say that it gives a bridge according to the money a town or county wishes to spend. Another concern stated plainly recently, 'There are good bridges, better bridges and best bridges, and we make all three kinds.' In one of this company's bridges, which it had guaranteed to carry safely a moving load of 3,000 lbs. to the running foot, and which it called one of its best, the iron in the lower chord was strained to 15,000 lbs. per inch by the weight of the bridge alone, and to 46,000 lbs. per inch by the guaranteed safe load; and by the

company's own admission it builds two classes of bridges inferior to this."

There are many things which people of little or no experience in such matters are likely to overlook, but the importance of which they readily see when their attention is called to them. For instance, either truss of the bridge under the requirement of 18 ft. roadway and two exterior 5 ft. sidewalks, with 80 lbs. per square ft. over all, will be more heavily strained with a load on roadway and the adjacent sidewalk than with load on roadway and both sidewalks, and the strain sheet should be calculated on this basis. The cross floor beams should be designed both for load on roadway alone and on both sidewalks only, as well as for load over all.

The cutting up of a bridge into a number of short panels tends to produce slender parts and hence a bridge lacking in rigidity.

All parts which come into close contact should be well painted in the shop, to prevent rusting, as such places cannot be reached by paint afterwards; all other parts should be everywhere accessible to the paint brush and to inspection. Hence closed column sections are not so good as open ones.

A tension or compression member which also carries a transverse load of any magnitude, is very seriously weakened by such loading, and its cross-section, or notably its depth, should be increased to resist the bending moments caused thereby. The practice of carrying the floor joists of some bowstring or arched truss bridges at frequent intervals on the slender bars of the bottom chord is very reprehensible.

Members subject to alternating strains of tension and compression need to be made larger than would be necessary to resist stress of but one kind. If we recall how much more readily a wire may be broken by bending it backwards and forwards than by bending it in one direction only, we may see the force of this suggestion.

The floor of a highway bridge should be proportioned to carry a heavy concentrated load as well as a distributed load.

A good allowance for wind pressure against the sides of the trusses and bridge should be made, and connections and portal bracing of proper strength should be put in to carry the wind pressure against the top of the bridge down to the abutments, where it must finally be resisted.

Let the waterway be wide enough and the height of the bridge above the river be sufficient to make it safe against freshets, moving ice and driftwood.

To quote again from Prof. Vose:

"To buy a good bridge - first determine precisely what you want; and if you don't know anything in regard to bridge building yourself, employ an engineer who does, to make a specification stating exactly what you want and what you mean to have. Then advertise for bridge builders to

send in plans and proposals. Let the contractors understand that all plans and competitions are to be submitted to your engineer, that all materials and workmanship will be submitted to your inspectors, and that the whole structure is to be made subject to the supervision of a competent engineer, and accepted by him for you. You will find at once that, under such conditions, all traveling agents and builders of cheap bridges will avoid you as the thief does the light of day. You will have genuine proposals from responsible companies, and their bids should be submitted to your engineer. When you have made your choice, let the contract be written by your lawyer, and have the plans and specifications attached. Employ a competent engineer to inspect the work as it goes on; and when it is done your will have a bridge which will be warranted absolutely sound by the best authority. This mode of buying a bridge is very uncommon."

The *Railroad Gazette* suggests:

"Suppose we should send a man round the country to place a sign upon each bridge stating in plain terms the exact condition of the work, we should have something like this: 'This bridge is guaranteed to carry a moving load of one ton per running foot, but half that load will break it down.' 'The iron in this bridge is strained to double its safe limit by the weight of the bridge alone; passengers will please to tread easy.' 'Not more than one team at a time must go over this bridge, and not over twenty people must cross at the same time; it is liable to fall at any moment with a heavy load.' 'The public is warned not to cross this bridge when the wind blows, as it has no lateral bracings.' 'This bridge will be closed until next summer as the weight of the snow upon it is all that it can safely carry.' [You may laugh, gentlemen, but imagine yourselves among the tax-payers who were swindled into paying for such structures, or the travelers who have occasion to pass over those death-traps.] What would the long-suffering, tax-paying public say to notices of this kind? Would they think they had their money's worth in the bridge?"

Yet this is exactly what ought to be placed upon a very large number of the highway bridges in this country. Suppose we should employ competent engineers to examine every highway bridge in the country, and that in every town and county a statement of the exact strength of the bridge should be publicly posted, with the names of the builders and of the town officials who bought the bridge. Would not a good many men find themselves in a disagreeable position? We can hardly expect to make public the bribery and corruption that in many cases enter into the highway bridge work; but we can make known the exact condition of any bridge. We can show about what risk the public is subjected to, and we can give the names of the officials who are accountable for that risk. "When the disease is fully

recognized, and not until then, will the public demand a cure. The demand for honest bridge work must be felt before the supply can be offered by any organization."

PRESIDENT STEELE:—"Gentlemen, have you any remarks to make on the subject of this paper? None. We have with us one of the old Engineers of the State, Mr. Forster, who will give us a paper on the Portage Lake and Lake Superior canal."

Portage Lake and Lake Superior Ship Canal.

By request of the honorable Secretary of this Association I have prepared a history of this Michigan improvement. This canal is in Houghton county, in the Upper Peninsula of Michigan. It connects Portage Lake with Lake Superior on the north. Portage lake is a long, narrow, tortuous sheet of water, about 20 miles long and from one-half to three miles wide. This in a north and south line, the main axis. A prominent arm extends in a northeasterly direction to Torch Lake, the site of the great stamp mills of the Calumet and Hecla, the Tamarack and Osceola copper mining companies. You reach Portage lake from Keweenaw bay by passing through a very crooked and narrow river called Portage. The stream has been rendered navigable by dredging and pier work. Mining corporations and one private firm undertook the improvement in the year 1859. In the spring of 1860 (June) the first steamer arrived at the docks of Houghton and Hancock, piloted by the undersigned, who was the engineer who planned, laid out, and superintended the work. This event was the beginning of a great revolution in business circles in the Portage copper district.

Where the flourishing towns of Houghton and Hancock lie clinging to the hillsides, in the heart of the copper district, the lake fills a deep gorge, which was evidently cut by a glacier. Here the original depth of water was 60 feet; the bottom was shaped like a trough and the solid trap rock composing it was smoothed as with a mighty planer. On the north side of the river-like lake, the banks sweep up steeply to an elevation of 600 feet; on the south, the heights are 400 feet above water, with irregular slopes, owing to the outcropping of hard, unyielding rocks. There are drift terraces on both sides of the lake, with more than one horizon, composed of massive rounded boulders and gravel, with a thin covering of sandy soil.

The scenery here, and all along up to the canal, a distance of 12 miles, before the "vandal ax" of man despoiled it, was very beautiful and picturesque. The high declivities, clothed thickly with hard and soft maple, pine, hemlock, balsam of fir, poplar and mountain ash, were graceful settings to this placid inland lake. Some of the reaches reminded one of the Highlands of the Hudson. The water is of a dark brandy color, and there is no current. Portage Lake forms one of the finest harbors of refuge on

the whole chain of lakes, spacious enough to float the entire lake flotilla.

At the extreme northern end of the lake the ship canal begins. Why was it necessary to construct this canal? I will try to show. The only entrance to this grand lake harbor, and approach to the great copper mines, was by Portage river, already described. Vessels going further west, to Duluth or other points, found themselves at Houghton in a sack, so to speak. They were under the necessity of retracing their steps down the lake and river into Keweenaw bay, and thence make the long detour around stormy cape Keweenaw. After about 20 hours run, they arrived within 10 miles of the starting point, Houghton. The ship canal saves that time, those storms, and about 110 miles of sea voyage. No wonder the pioneers of those times—the business men, those who do business in ships—were anxious to secure such an important cut-off. It was their Suez, their Panama canal.

Early in the sixties, Congress was appealed to for aid. It finally granted to the State of Michigan 400,000 acres of land, located in the Upper Peninsula, to be devoted to the building of this canal. At its session of 1864-5 the Legislature accepted the grant, and passed a bill giving effect to it. The contract for building the canal was let to Avery & Co. The work of preparing plans and specifications, making surveys, laying out the canal, and engineering supervision, was, by the act, put into the hands of the governor and of the engineer whom he shall appoint. The act specified that the engineer should receive not more than $2,500 per year for his services. But mark you, brother engineers, one of the novelties of this act. There was no fund set aside to pay the engineer with: the contractors were to pay him! Imagine yourselves thus placed at the tender mercies of contractors, where conflicts were sure to arise! This curious feature did give rise to infinite trouble. For two whole years the undersigned received no pay, because he insisted upon having the work done "according to plans and specifications." He was told to go to hades more than once, but he stuck to them like shoemaker's wax and finally triumphed. The only club he held over unprincipled contractors, or their agents, and it was an effective one, was this. The act recited that upon the final completion of the canal, according to law, the governor should certify the fact. The engineer should also certify, independent of the governor; and these two certificates would entitle them to their lands. Without both certificates they could get no pay. There the engineer had them on the hip. Before closing this topic, of interest to engineers, I would state, that the company had a famous engineer from the East to manage for them. He was accomplished, advanced in years, but impracticable, extravagant and obstinate—I was going to say, pig-headed, but that would be impolite.

In 1867, J. N. Greene, C. E., was appointed by Governor Crapo, the first engineer. Greene prepared "plans and specifications" for the entire work, which were approved by the governor and thereby became part of

the law. He laid out the work on land, staking out two tangent lines and one six degree curve. But he did no hydographic work for breakwater, foundation and channelways into the lakes.

I took charge in the spring of 1869, having been appointed State's engineer by Gov. Baldwin—Greene retiring with Gov. Crapo, or soon after. I found the condition of the work as follows: The canalway had been cleared of timber the whole length and breadth required, and two dredges were at work at the Portage Lake end. About 600 feet in length of the canal was partially dredged. A dock, dwelling houses, machine shop, carpenter shop, stables, etc., had been built. This was the show after two season's work. No doubt much money had been expended. Yet a deluded member of Congress was induced to bring in a bill asking for an additional 200,000 acres of land to further the work, basing his demand upon the fact that one-half of the canal was finished. Congress did not grant the land.

The route followed by the canal was known in history as the Grand Portage. Here the Indians, from time immemorable, in war and peace, made the portage; here the zealous Jesuit fathers hauled their canoes across and set up a cross on the shore of Lac Tracy, as they named Superior; here General Cass, in his famous expedition, whose object was the discovery of the source of the Mississippi, was fain to haul his canoes and batteaux over the long portage.

The canal is 2 miles 600 feet long from shore to shore; its width 100 feet at surface of water, 80 feet at bottom of canal. It was to be dredged 13 feet deep. At the Portage Lake end piers were to be run out into deep water, flaringly, so as to admit of an easy entrance. Double rows of piling were used here, with crib heads for beacon lights. There being no sea, these were considered sufficient. The prism of the canal, when necessary, was to be lined on both sides with sheet piling (docks), constructed as follows: Two rows of heavy Norway pine or oak piles were driven. The piles were 6 feet apart in each line and 7 feet apart from front to rear. The front and rear piles were fastened together with ties dovetailed and bolted. The front row of piles had 2 stringers a foot square running longitudinally and securely bolted with iron. Behind this superstructure sheet piles—plank 4 inches thick—were driven down with a pile driver, close together and spiked to the stringers. When there was any quicksand, inch boards were driven behind the sheeting so as to cover cracks.

I now proceed with a fuller description of the land sections of the canal, protected as above. Beginning at the south or Portage Lake end, we run on a tangent line 5,300 feet through a cedar and tamarack swamp. There was some very hard ground, containing bowlders. It crossed or followed a narrow creek which had been used by canoes. Then we came to Lily pond, a small lake filled up with lily pads and grass. There was some open water. It was in Lily pond that the curve was made. The

bottom was black ooze or muck, very deep; piles 30 to 40 feet long had to be used here to get firm hold on the sub-clay bottom. On this curve the canal was made 250 feet wide, as a turnout, or passing place for steamers, likewise as a resting place in stormy weather. Passing Lily pond section we came to firmer land—a tamarack swamp; it was marshy but gradually rising. Here we found in going down 13 feet that we had to pass through almost a solid mass of fallen timber, roots and stumps. It was a very difficult piece of work, racking and breaking the dredge terribly, and every root, log and stump had to be handled by men with axes and grub-hoes. The dipper could not discharge itself. When we got through, the banks of the canal were lined with the remains of these ancient forests, 15 to 20 feet high. After drying, the rubbish was burned. We found forest upon forest there; found, for example, stumps 2 feet in diameter resting in their natural beds, surmounted by stumps of the same size which had evidently sprung up after the demise of the elder trees. The ancient forest trees were of much larger size than those we found growing on the surface. They were tamarack, hardly a foot in diameter at the base.

Leaving this marsh section we, by an easy slope, reached the so-called sand section. This division embraced about one-third of the length of the canal. It was the heaviest portion of the work. It was originally covered with a beautiful forest of Norway pine; some parts of the ridge were 40 feet above the lake surface. To remove this great mass of sand from the natural surface to the water line, men with picks and shovels were used, with 100 horses, carts and cars. The spoil banks were on the sides of the canal in the swamps or in Lake Superior. At some points the top of the slopes were from 200 to 250 feet apart. The material was beach sand and small gravel. Afterward, steam cars, railroads with T rail and 2 locomotives were used. With this equipment and the character of material to be handled, the work progressed rapidly. Undoubtedly at some remote age, the waters of Portage Lake have had free flow into Lake Superior, and therefore Keweenaw point was once an island, as it is now, by reason of the canal. We found at a depth of 30 feet below the roots of the pine forests which had clothed the ridge, sound oak logs that had drifted in there. At a greater depth we found the end of a pike pole, rudely made of copper, 18 inches long and 2 inches in diameter at the large end, hollow and pointed at small end. It was bright as a new copper kettle. We also found in dredging, stone hammers so common at the mines—remains of the so-called ancient miner. We likewise found in the pine grove east of the canal, in laying water pipes, a grave containing several copper tools, a tooth and a string of rude copper beads. In the bottom of the excavation there was a thin layer of black mold—all that was left of the human body deposited in that pure white sand ages ago.

On the immediate shore of Lake Superior the banks were from 10 to 20 feet high. Between this highwater line and the water was a shingle

beach composed of flat sandstone, well water-worn, transported by the waves from the sandstone bluffs a mile to the westward. Under this shingle, and for several hundred feet inland, we found by dredging, a stratum of the hardest kind of hard-pan. Ordinary dredges could make no impression upon it. A powerful $20,000 dredge was made expressly to attack it. But it was so hard that the dipper armed with long steel teeth could not move it. It only scratched the greasy, tenacious mass. The few yards removed cost at least five dollars per cubic yard, while the other material, sand or muck, cost 18 cents. The company's engineer persisted with his usual obstinacy until he tore the cram out of the dredge and put her *hors de combat*. I suggested—I could do no more—to blast the ground, shake it up with dynamite, or nitro-glycerine. But my idea, being Western, was treated with contempt and the work was abandoned for the time being. The next season, for causes not necessary to mention here, the company's engineer did not put in an appearance. I came onto the ground armed with plenary power. I sent for two of my old miners, some heavy drill steel, twelve feet long, some nitro-glycerine and an electric battery. I caused from 20 to 30 holes to be drilled 10 feet deep, dropped cartridges into the holes, using the overflowing water for tamping. The battery was fired and an explosion followed, like a small earthquake. The muddy water boiled and bubbled for some time. Leaving the water to permeate and soften the mass, for a few days, I then set an ordinary dredge at work there, and the material was moved easily and rapidly.

Driving piles in this clay and in some kinds of sand required heavy, powerful steam hammers. The piles had to be shod with iron and banded at the head. On the Lake Superior side, heavy piers or breakwaters had to be built. Before locating, I had to make a hydrographic survey, taking minute soundings. I placed a large number of flag buoys opposite the mouth of the canal so as to cover the whole bottom out to 30 feet of water. With a boat, I sounded from buoy to buoy, cutting up the ground into small triangles, having the lines cross in every direction. From a base line on shore I located the buoys by triangulation. In my office, from this data, I plotted the work, making a complete map of the bottom. The soundings were in feet and tenths of feet. From my map I laid out the position of the breakwaters and ascertained how much dredging had to be done for the piers and channel way.

The plans and specifications for the breakwaters required that said breakwaters should begin at highwater mark and run on parallel lines out into the lake to deep water. I located the outer end of main breakwater in 21 feet of water. The breakwaters were to be 250 feet apart. The cribs, 50 feet long by 20 wide, were built of sound Norway pine timber one foot square and counter-hewed; the cribs were 20 to 30 feet wide, according to position. The longitudinal timbers were bolted together with one inch iron 2½ feet long. The cribs were held together with numerous crossties, dovetailed into the side timbers. The beds for these cribs, in shoal

water, were dredged to a depth of 13 feet. At the head of the breakwaters, cribs 30 by 50 feet were sunk so as to present a solid front to the tremendous seas that break upon them during the stormy season. The sea faces of these cribs, above low-water mark, were cased with heavy boiler iron so as to resist abrasion by ice floes. All of the cribs were filled to the top with sound sandstone from quarries near at hand, or with bowlders and trap rock brought from the mines in scows. The superstructure was eight feet above the water. Finally the whole work was covered with 4 inch thick Norway pine planking, spiked down to the ties, with a stringer on the outer edges, bolted on top of the planks and into the side timbers. The breakwaters were 800 and 900 feet long, 250 feet asunder, as before mentioned. A short length of splaying at the shore end narrowed the space so as to join the inside piling of the canal proper, which was of course 100 feet wide. And here appeared a very serious defect in the original plan of Engineer Greene. The docks and sheet piling joined the breakwaters too close to the lake shore. The heavy seas, rushing up the channel way, produced much commotion, tearing up the docks and piles. I remedied the defect as much as my iron-bound instructions would permit. I continued a narrow crib-work filled with stone 200 feet into the canal. Beyond that for several hundred feet I loaded the piled docks with stone and thus saved the high sand banks from caving in. But the original specifications should have called for at least 800 feet of interior cribbing. I so stated to the Governor in Detroit when I looked at the plans, before going on to the work; but the approved plans could not be changed any more than the laws of the Medes and Persians. Red tape is inexorable!

My manner of sinking cribs was as follows: I endeavored to get as many cribs sunk during our short season as possible; leaving the tops only a foot or two above the water. The heavy gales of winter and the accumulated ice, would shake and press these loaded cribs down into the tenacious clay so far, that in the spring, when work was resumed, nothing could be seen of them. Upon this firmly settled base the superstructure was erected. The wisdom of this policy is apparent now. After 14 years of battering on that exposed coast the cribs are as firm as solid rock. I examined the breakwaters ten years after completion and I could not see that they were out of line one inch. The piers were protected, on the weather sides, by rip-rap walls.

In winter the restless lake is seldom frozen over, but packs of ice are constantly moving about. The water dashes upon these breakwaters and freezing as it falls, piles up ice hummocks from 20 to 30 feet high. This is a great protection against drift ice. I will say, in this connection, that work on the canal could only be prosecuted during the summer season, that is, from May to November. Not much water work could be done after August. This you will bear in mind, when you are told that the work was seven years in building.

The canal was well equipped with machinery, having 5 dredges, numerous dump, stone and timber scows, 2 locomotives, 3 tug boats, 3 pile drivers, 1 machine shop, 1 dry dock, 2 blacksmith shops, 1 carpenter shop, many dwelling and boarding houses. The dredging went on night and day. Sometimes as many as 800 men were engaged on the work, including many superintendents and skilled mechanics. In the winter a reduced force was employed in repairing machinery, in getting out fuel and timber.

At the beginning of dredging a bench mark had to be established, and daily reference had to it in order to guide and check up the dredgers. The surface of those waters is constantly changing. It varies from a few inches to several feet in stormy weather. An engineer dredging anywhere on the great lakes must look sharply for the fluctuation of the water. There are daily rises and falls, yearly, and for a much longer period. This has not all been accounted for. The winds, the pressure of the atmosphere, may account for daily changes. Yearly changes may also be explained by the great solar evaporation in summer, great precipitation of snow and rain in winter; but for the great secular pertubations it is not so easy to state a reason.

To illustrate: When I was acting as engineer on the Portage river improvement, I placed a bench mark. I had been watching the water for several years previous, while acting as U. S. assistant engineer on the St. Mary's river. I knew perfectly well that the level of Lake Superior was falling. The Portage River Improvement Company required a depth of 10 feet of water. This was in 1859. I astonished the directors by stating, "Then you must now dredge to 13 feet." I gave my reasons; but they were incredulous. They had not much faith in scientific lore. They said, "Dig 10 feet." I did. In just three years from that time my bench-mark told me the water had fallen 37 inches! And vessels were grounding in 7 feet of water! The dredges had to be started up again. On our ship canal I sounded after the dredges, frequently checking them up. I had the dipper cranes marked so that the dipper tender, guided by the bench-mark, could tell just how deep to dredge.

The Portage Lake and Lake Superior Ship Canal was finished in the fall of 1873. Not having anything to do with the finances of the company I cannot tell how much the work cost. But I estimate the cost at about $3,000,000. There was no necessity for this great outlay and I am of the opinion that the entire work could have been accomplished for one-half that sum and yielded a handsome profit to skilled and economical contractors. There was enormous waste of time, material and money. There was great lack of brains. There was one brain the company paid $10,000 a year for to their great damage. Frequent changes in management caused great confusion and loss. The want of ready money to pay employes was most damaging. The company issued bonds which they hypothecated at 40 cents on the dollar to procure money for the work. The original com-

pany bankrupted two years before the work was finished. The bondholders went on with the work and completed it. Those people or their assignees now own and operate the canal, receiving toll from all that pass through. It is not a good paying investment on the money expended, but the owners do not care much. The 400,000 acres of land, appropriated for the construction of the canal, has become so valuable in its pine and mineral products as to make the owners millionaires.

The original contractors and owners have passed from the scene. For all their enterprise and worry I do not believe they finally realized a dollar. Some of them, I know, passed off of the world's stage broken-hearted; others may be still living to realize how futile sometimes are the best laid plans of mice and men.

PRESIDENT STEELE:—"The next paper on the programme is on the Improvement of the Middle Neebish Rapids."

Improvement of the Middle Neebish Rapids.

This work is part of the Hay Lake Channel Improvement, which is being done by the United States under the direction of General O. M. Poe. The rapids connect Hay Lake with the present navigable channel, and are at foot of Sugar Island, some sixteen miles below St. Mary's Falls Canal. A survey of Hay Lake was made in 1872, from which estimates were made of the cost of two proposed channels, one by the way of the Middle Neebish and the other by the West Neebish Rapids.

In 1879 a more complete survey was made of the rapids by the method of cork-line soundings, and the location of the channel established. It was to be 300 feet wide and 17 feet deep. The estimate for excavating the sandstone at the Middle Neebish was 3 and 40-100 dollars per cubic yard, or $1,395,440 for that part of the channel, and $2,127,292 for the whole improvement. The depth of the channel was afterwards changed to 19 feet, and finally increased to 20 feet, the cost of the modified project being increased to $2,659,115.

The following were among the reasons given for improving this route: By the steamboat channel, via Lake George, the distance from the canal to the head of Mud Lake is 35 miles. In this distance there were twenty-five shoal places, at which dredging was done during the seasons of 1879, '80 and '81, at a cost of some $200,000 in order to obtain an available depth of 16 feet. This portion of the channel is very tortuous and difficult to navigate in the day time and cannot be used at night. The distance from the canal to the head of Mud Lake by the way of Hay Lake is only 24 miles, making a saving of 11 miles in distance, through the worst part of the river, and by putting up seven pairs of range lights it can be navigated day and night.

In 1881 the average cost of carrying freight was 2.8 mills per ton per mile. The tonnage that passed through the canal from 1855 to the end of 1881 was 21,417,159 tons, upon which the loss due to 11 miles of bad navigation was $695,648. The loss on 2,013,000 tons that passed through the canal in 1881 was $62,000.* The greatest loss, however, is that due to the impossibility of night navigation. In 1881 this loss was $354,800, and from both sources we have the sum of $316,800, which capitalized at the rate of 3½ per cent. per annum amounts to over $9,000,000. Since that time the cost of freighting has been reduced, but the tonnage has enormously increased, so that the loss from not having the new channel is greater. At the close of the season of 1887, the total amount of freight that had passed through the canal was 42,110,750 tons, and the freight in 1887 suffering for lack of this facility was 5,494,649 tons.

$475,000 have been appropriated by Congress for improving the Hay Lake channel. The first appropriation was made in August, 1882. The following October, a dredge owned by John Hickler, was employed by the hour, and beginning at the upper end of the rock work, five test pits, 19 feet deep and 300 feet apart were dug along the center line of the proposed channel. In the last pit the rock was within 8 feet of the water surface, and was easily dredged, at a cost of only 35 cents per cubic yard, scow measure. For a mile below this pit the bed rock was very level and covered with numerous bowlders and stony shoals, so that it was difficult to pilot a tug drawing six feet of water amongst them safely. This necessitated first making a channel only 100 feet wide through the rapids. On February 5, 1883, a contract was made with John Hickler to dredge a channel 100 feet wide and 19 feet deep from the angle at foot of Hay Lake down to the lowest test pit, a distance of 4,000 feet, at seventy-two (72c) cents per cubic yard, bank measure.

During the season of 1883 the surveys for determining the amount of material to be excavated were made as follows: A number of transit stations were established along the shores and connected with a system of triangulation. Through the flats at the foot of Hay Lake there was not much current, and the material to be removed is principally sand and silt. There, the sections were taken fifty feet apart, 400 feet long, and soundings every 10 feet on each section. Two parallel lines of tamarack stakes, 400 feet apart, and the distance between consecutive stakes on each line, 500 feet, were driven with a small pile driver placed on a scow, the position of which was located by the intersection of transit pointings from two of the shore stations. The scow was kept in position with four dredges and lines. From 15 to twenty stakes were driven in a day. Eight men were employed, viz: 2 transitmen and 6 laborers. The soundings were located as follows: Two side lines, each 500 feet long and ¼ inch in diameter, and on which were fastened cedar corks every 50 feet, were stretched between consecutive stakes on the side channel line. Two small Mackinac boats, in each of which were two men, were anchored at

corresponding corks on the side lines. A steel wire ¼ inch in diameter, which was tagged every ten feet for 400 feet, was stretched between the side boats and the soundings were taken from a third boat at each tag on the cross line. Water gauge readings were taken quarter hourly at gauges along the shore and opposite the soundings. With favorable weather an area 400x2,200 feet would be sounded over in one day.

Down through the rapids a channel only 200 feet wide was first surveyed. The parallel lines of stakes were driven that distance apart. The stakes were 260 feet apart in the direction of the channel. Where it was possible, sharpened bars of old railroad iron were driven in the rock, otherwise holes were drilled two feet deep in the rock, in which the bars were inserted. A raft 130 feet long and 20 feet wide, with a spud at each end, was anchored with its upper end on line between the first pair of stakes, and one side in line with the row of stakes. It was swung into position by means of 5 kedges and lines, two on each side and one up stream; the spuds were used to help hold it in position. Soundings were then taken every 10 feet along each side and through the middle. The raft was then moved sidewise 30 feet at a time, this distance being known by means of tags on two or more light cross lines that were stretched above the water between two opposite stakes, and the taking of soundings repeated till the raft was moved from one line of stakes to the other. It was then dropped down stream till its lower end was between the second pair of stakes, and the operation repeated. With 5 men on the raft an area of 200x1,040 feet could be sounded over in one day, under the most favorable circumstances. Soundings were afterwards taken for 100 feet north and 100 feet south of the first survey, making the total area sounded by the raft method 400 feet wide and 10,400 feet long. The monthly estimates were taken in the same manner as the original surveys were made.

Whenever a contract is completed, five bars, each 27 feet long, are suspended from the raft by means of chains fastened to windlasses, and lowered to grade line, and the raft then swung over the required area. The bars are sure to strike on all points projecting above grade line. At intervals during the season of 1883 duplicate and opposite lines of precise levels were run between the canal and the foot of Sugar Island. Also a series of beach marks, which were opposite the ten water gauges that had been established on the Sugar Island shore, were connected with precise levels. The total length of the level line was 27 miles. By means of simultaneous quarter hourly reading at the various water gauges, the fall at the Middle Neebish was found to be about 8 inches, and the fall from the canal to the foot of the Neebish rapids about 17 inches. For the purpose of learning the character of the rock, amount of blasting necessary, cost of blasting, dredging, etc., it was decided to use the government drill scow, and to employ a dredge, by the working hour, to do experimental work in various places. In 1883 the United States em-

ployed one of C. S. Barker's dredges, and the digging of test pits continued. Although attempts were made every 200 feet, this dredge did not succeed in excavating the rock below 14 feet, without first blasting it, till a place was reached nearly 4,000 feet below the last pit of the previous year. Before drilling, it was necessary to scrape off the soft, decomposed rock, generally five or six feet deep. The holes were drilled 5x5 feet apart, and to a grade of 2.3 feet. The depth of the holes in rock varied from 6 to 10 feet, but generally were about 8 feet deep. In some places the holes were 6x7, and even 7x8 feet apart, but in these cases, if the rock was very hard, it was sometimes necessary to redrill it before the dredge could dig it to advantage. In 1884 Williams and Upham furnished a dredge for the experimental work, which was employed till November, 1886, when this kind of work was discontinued. In 1886, an area 1,000x35 feet was drilled and blasted. The number of working days was 127. The number of holes was 12,700, or 10 per day. The average charge was four and one-quarter pounds of Hercules powder, No. 2. The cost of drilling was $1.09 per yard, and the cost of dredging the blasted rock was $1.08 per cubic yard, bank measure. The dredge was also employed in widening the 100 ft. channel. As no blasting was done, the depth of the cut varied from 13 to 22 feet. The cost was $1.06 per yard. The following is a summary of the experimental work:

DATE	NO. OF CUBIC YARDS EXCAVATED, BANK MEASURE	CHARACTER OF THE WORK	COST PER CUB. Y'D, BANK MEASURE
1882 } 1883 }	7341	Test Pits.	$ .63
1884	6850	Blasted and scraping	1.34
1885	2991	Blasted and scraping	1.47
	2600	Blasted	2.51
1886	6263	Blasted	2.17
	10068	Scraping	1.06
	Totals, 36113		Av'e, $1.53

From a careful examination of the information obtained from the experimental work, it is estimated for a completed channel through the rock work, 300 feet wide and twenty feet deep, that forty per cent. of the material will need blasting, and sixty per cent. of it can be dredged without blasting, and that the average cost will be $1.80 per cubic yard. The ratio between scow and bank measure varied in different seasons and in different portions of the work from two per cent. to fifty-six per cent.; but generally the scow exceeded the bank measure by about twenty-five per cent. A statement is given of the total amount of material that has been excavated in improving the Middle Neebish from 1882 to 1887, both inclusive.

DATE OF CONTRACTS	CONTRACTORS	CHANNEL	TOTAL C. Y'DS EXCAVATED, B'K MEASURE	COST PER C.YD
		Width Depth Length		
Feb'y 28, 1883..	John Hickler	100 x 19 x 4,000	201,080	$ .72
Sept. 5, 1884..	Hickler & Green	100 x 20 x 1,200	59,411	.58
May 18, 1885..	Hickler & Green	100x14 at least x3,200	38,333	.89
Dec. 24, 1886..	Hickler & Green	300 x 20 x 700	44,086 in force	1.95
Experim't'l w'rk		21	36,113	1.53

The first season's work developed the fact that a double engine, friction dredge could not dig the rock to advantage where a single engine, clutch dredge with a heavy fly-wheel would excavate quite readily. The contractors, Hickler & Green, built larger and more powerful dredges from season to season. Last spring the firm of Carkin, Stickney & Cram built the largest and strongest dredge on the lakes. The forward spuds are of oak and twenty-six inches square; the hoisting chain is made out of one and one-half inch iron and the fly-wheel weighs 5,400 pounds. Although this dredge was able to excavate any of the rock in the Middle Neebish, it was found to be greater economy to do a certain amount of blasting before dredging the hardest portions of the rock.

PRESIDENT STEELE.—"What system is used for measuring the work of the dredge?"

MR. RIPLEY.—"The contract is all by the cubic yard."

DR. FOSTER PRATT.—"I have been informed by the City Engineer that quite a number here would perhaps be interested in studying the mechanical appliances of the asylum. In that case I take the liberty of extending to you a cordial invitation to visit the institution at any time you find it convenient to do so. Please give me a little notice in advance."

PRESIDENT STEELE.—"In behalf of the Society I thank the Doctor for the invitation. We will consider it and notify him in season. Mr. H. C. Pearson has submitted the following resolution in writing:"

Resolved: That the County Surveyor should also be made County Engineer and have charge of the work on the highways, bridges, and drains throughout the county.

MR. PEARSON.—"The resolution was to elicit an informal discussion as to what would be desirable, and it comes in as a fit supplement to Prof. Greene's paper."

MR. STRONG. "Those who are acquainted with the duties of a Road Commissioner and have followed the business of a Surveyor do not want it. There is too much drudgery to it. A man cannot be expected to know the wants of a whole county. The idea of a surveyor being called on to

say whether he will allow a petition for a bridge, or abate an encroachment on the highway! I don't think we want to do it."

MR. PEARSON.—"The resolution does not expect all this of the surveyor, or that he will be charged with finding out where the work is necessary, or whether the people want it. But if work is to be done put him in charge of it."

MR. APPLETON.—"We ought to go slow in piling too much work on one officer. I can imagine cases where a surveyor might be a very good surveyor, and not a good bridge builder. This highway work and bridge work will keep a man very busy."

MR. PEARSON.—"How does a State officer get along? Our County Surveyor has power to appoint all the deputies he wants."

MR. APPLETON.—"That might be done, perhaps, dividing the county into districts; still I think it would be putting too much on one man for him to be responsible for. Why not make the districts smaller and let the Board of Supervisors appoint the Engineer for each district. Unless a man had the active charge or supervision of the work it seems to me it would be very likely to fall through."

MR. HODGMAN.—"I have heard this matter talked over and the work discussed in four different Surveyors' Conventions before, but those discussions have all been from a different point of view than this one. In Ohio and some other States the system contemplated by the resolution is in practice. There the County Surveyor is by virtue of his office a member of a Board of three County Drain Commissioners, and engineers all the county drains. He has charge of the road improvements, and the long lines of splendid pikes in that State testify to the value of the system. When I go among their surveyors the main things I hear them talking about are the drains they are making and how to apportion the benefits, the miles of pike road they have built and how it was done and paid for, and what kind of bridges to put over their streams. The air is full of it in their conventions. We in Michigan are a long way behind Ohio in the building of roads, drains and bridges, and will continue to be behind as long as we follow our present plan of having no system at all."

MR. FORSTER.—"It is my experience that County Surveyors do not have much to do. I think it would be one of the best things in the world to have this resolution carried out to its full extent, and see if we could not have something new under the sun in building bridges and roads."

PRESIDENT STEELE.—"I have here a communication from O. S. Shaw, which is in point. It describes the trouble he has in getting pay for surveying done for the Township Drain Commissioner. Some of it he has to wait a year and a half for, and some he never gets."

MR. FOSDICK.—"Our drain law is defective in that respect and I have

had the same kind of an experience; but if the drain is built they give us an order on that drain fund, and we get it in the course of time."

MR. SKEELS.—"I have not seen anything better than my system of getting pay for this kind of work. One experience was enough for me. I say, 'Gentlemen, when you pay me for what I have done I will survey another ditch for you; not until then.' If we cannot make a living at our profession it is time we got into something else."

MR. SEXTON.—"I move the adoption of the resolution. When they have appointed a man for this work I would like to have them provide a fund to pay him."

MR. APPLETON.—"I see nothing to be gained by adopting this resolution. It calls for a radical change and you should take in all the points. I would move that it be referred to a committee of three, who shall look the matter over in all its bearings and draft a law and submit in time to bring before the Legislature. It would be a good subject for debate at our next meeting." Supported.

MR. PEARSON.—"We cannot do anything more than to recommend. The object now is simply to find out what we want. We could only appoint a committee to get it in shape for the next Legislature."

MR. HODGMAN.—"I hope we shall have as full a discussion as we have time to indulge in on this point, to bring out what we think to be good and desirable. I desire it for the reason that we have with us the member of the Legislature from this district, who will in all probability be also a member of the next Legislature, so that he may know fully just what we want and why we want it."

MR. STRONG.—"Something ought to be done to improve the drain law. The most important drains meet the most opposition."

MR. MERRILL.—"I have read the drain law carefully and worked under it and don't see how it can be amended to make it any better."

MR. STEELE.—"It occurs to me that we do not fully consider what we are attempting to do by this resolution. We are proposing to modify the drain law; to do away with the Highway Commissioner; to make practically a new officer called a County Engineer. If you fully realize the difficulty of accomplishing these ends through the Legislature, why go ahead. If not, you had better go slow. We attempted some years ago to get the Legislature to do something with the County Surveyor. The office does not amount to the snap of the finger; there is nothing to do whatever. It ought to be wiped out at one stroke. There is a good deal in this resolution and it meets my approval in one respect, that it puts something into the County Surveyor's office."

MR. HODGMAN.—"The County Surveyor amounts to something in this part of the State. In this county since 1838 he has settled peaceably

more than ninety-nine per cent. of all the disputes over boundary lines that have been settled, and the courts have never yet gone back on him. He has something to do and the office is respected. He might do a good deal more. I do not care whether the Legislature abolishes the office or not. It seems to me the way to deal with this matter is to refer it to a committee who will give it their attention and work it up so far as we cannot do it here, and then at the proper time if it is thought best we can appeal it to the Legislature."

MR. TEED.—"I think it should be referred to a committee for the reason just suggested. In cities the engineering work is done on a system, under Engineers selected for the purpose; in counties there is no such system. What is wanted is a system for the county that the engineering work of the county shall be under the same kind of a system that the city work is. It will never get there unless it is adopted and worked up by this Society."

MR. SKEELS.—"If it is referred to a committee let them look up the matter as it is in operation in other States and select the best. Let us not try to do too many things at once. If we can get the Legislature interested in one thing we can have patience and in time secure what is necessary."

MR. STEELE.—"There are but few men who are specially qualified for that position, but they will spring up with the demand. Our schools are graduating them every year. I am greatly in favor of the resolution. We need something of that sort before we shall have good roads and good bridges."

MR. SKEELS.—"My proposition was to have these officers appointed by the Board of Supervisors."

MR. PEARSON.—"It would be better to have the officer appointed by the Board of Supervisors. There will be less chance for political influence than where the office is elective."

MR. HEMENWAY.—"It seems to me this resolution is putting a good deal of responsibility on one man."

MR. APPLETON.—"It would be a world of responsibility to put on one man's shoulders. If we are going to ask the Legislature for a change like this we ought to first refer it to a committee who could take a good deal of time and work it up carefully, and I have a good deal of confidence in my friend Hodgman in such a thing. Surveyors who are very competent—the best possible in that line, having given their time and attention to it—might be very poor bridge builders. All these things should be thought of."

MR. SKEELS.—"The real object of the resolution is to get just that

class of men in the position that Mr. Appleton says is necessary for the place, and I favor it."

Mr. Appleton's motion was then put and carried, and the Society adjourned for the day.

THURSDAY MORNING SESSION.

In response to a call for correspondence in the hands of the Secretary, that officer presented correspondence with Mr. A. L. Wright, a collection agent at Bad Axe, in reference to a note in his hands against H. Strudwick for money lent him in 1882 by the Society; the agent desiring instructions as to whether he shall bring suit or not. After discussion it was left to the discretion of the Secretary.

In the absence of the Chairman of the Committee on National Public Works, Prof. C. E. Greene presented a report from that Committee not furnished for publication.

PRESIDENT STEELE.—"You have heard the report. Is there any discussion?"

MR. HODGMAN.—"We ought to take some action on this question. There is about $40 in my hands which has been contributed by members of the Society for the support of the Council of Engineering Societies. The committee itself is divided as to the propriety of the whole movement. Prof. Davis strongly favors it and Prof. Carpenter strongly opposes it. My friend, Frank P. Davis, who served several years in Government employ, has written me in terms unfavorable to the movement. About one-fourth of the members of the Society have shown by their contributions that they favored the movement. The rest are either indifferent or opposed to it. The expenses of the committee for the past year are to be paid out of the general fund of the Society, but as we are about starting out in a new Society and on a new basis, we ought, if we intend to continue the policy, to make a definite decision to that effect."

MR. STEELE.—"The matter has been pretty thoroughly discussed at our former meetings, and at Grand Rapids we decided that inasmuch as Prof. Davis had been sent as a representative by our Society and had paid the expenses out of his own pocket, he should be reimbursed by the Society and we would support him in whatever action he had taken so far; and out of regard to Prof. Davis we made that appropriation. A donation was then solicited and some of us threw in and it was a private contribution entirely outside of the Society. No member was obliged to give. Now as to the propriety of continuing this relief and involving ourselves in an expense which we do not know the amount of, I think it is a matter of grave doubt whether we ought to do it as a Society. It

looks to me as though the object was a mighty way off, and while of course we are all free to take our individual action, I am not in favor of this Society obligating itself as proposed."

MR. FORSTER.—"How much is Prof. Davis out in his expenses?"

MR. HODGMAN.—"So far as I know, not anything. We paid the expenses incurred in 1886. I have received no notice of the committee having incurred any expense the past year. If they have, we should have a bill of it and it will be paid out of the general fund of the Society. I have very strong doubts about it being good policy for us to continue doing that. I do not believe that we as a Society want to obligate ourselves for the support of a committee for that purpose."

MR. APPLETON.—"Would this Society, as a Society, have any earthly thing to do with it? That was raised for an object and it seems to me the Society would have nothing to do with it. Am I right?"

MR. HODGMAN.—"The Society has nothing to do with the individual contributions, but it has all to do with the general fund."

MR. FORSTER.—"I move that the report of the committee be accepted and the committee discharged." Carried.

Invention of the Solar Compass.

BY JOHN H. MULLETT.

Application having been made to the Michigan Engineering Society at its meeting at Ann Arbor, for its endorsement of a bill then before Congress granting several thousand dollars to the heirs of W. A. Burt for his invention of the Solar Compass, and it having been stated that John Mullett had done as much to perfect that instrument as Mr. Burt, I have been requested by your Secretary to tell what Mr. Mullett's connection with that instrument was.

William A. Burt and John Mullett were United States Deputy Surveyors, and had been for some time engaged in running exterior township lines, and were required by their instructions to ascertain the variation of the compass needle at least at each town corner; the only way of doing which in their power at that time was the old plumb-line and candle method of observing the north star, and then perhaps just at the critical moment some passing cloud would obscure the star and make all their watchfulness futile, which, after a hard day's work on the lines, was, to say the least, not very pleasant. Well, in talking over their troubles in that way one day, Mr. Mullett suggested that some instrument might be made whereby the variation could be found by the sun, on the sun-dial principle, perhaps. This seemed to strike Mr. Burt very favorably and after talking it over awhile they separated, each going to

his home. After a few days Mr. Burt came back with a block of wood on which he had fixed an arrangement of the movable arm, showing that the sun's rays, after passing through a small hole, made a bright spot upon a small plate at the other end of the arm, and when turned either to the right or left the bright spot would cross the plate. That was better than the shadow arrangement of the sun-dial. They both seemed to be very much pleased with that discovery and talked it over half the night. The next morning they repaired to Mr. Mullett's office, each with a sharp knife and a goodly handful of shingles, to whittle out a model of an instrument that could be attached to a compass. Certain things had to be provided for; the latitude, sun's declination, and a lens in the movable arm. Well, the result of their whittling was a model for the first solar attachment to a surveyor's compass, with which the variation of the needle could be found any time when the sun shone, except near noon. They were both well pleased with their work and agreed to have it patented; but Mr. Mullett being very busily engaged at that time in laying out into lots additions to the city of Detroit, Mr. Burt was to go East, get an instrument like the model made and attached to a compass, and then go to Washington and get a patent in the name of Burt & Mullett, Mr. Burt furnishing the time and Mr. Mullett the money necessary. I was present, heard all their talk, saw the first model made, and know it was the work of the brains and hands of both.

Mr. Burt, on his return from Washington, reported that certain affidavits were required of the inventors, and as Mr. Mullett was not present, his name was not inserted in the patent. Mr. Burt afterwards refunded to him the money he had paid. These facts were well known to all the surveyors in Michigan at the time. The instrument has been greatly improved by Mr. Burt in a way of making it more accurate and substantial, but nearly always with the advice and assistance of Mr. Mullett; in fact, it was their plaything and hobby for years.

Now the heirs of Mr. Burt claim it was never patented. If it was not, why was it always marked "Burt's Patent?" Why was W. J. Young for years sole maker for the patentee? Why was a royalty charged for every instrument made? Further, if it was not patented, and the Government proposes to donate to the inventors some of the surplus money in its treasury, why should not the heirs of John Mullett have a share? It has been said that there is no new thing under the sun. Is the solar compass an exception? It appears to me that the whole principle of it is in the old sun-dial which has been in use for centuries, and one of these of Burt's was made on a large scale and set up by Burt & Mullett on the corner of the streets in Detroit, near a jeweler's store, and used by him as a sun-dial to regulate his clock.

MR. HODGMAN.—"I have felt a very strong interest in this matter ever since we were told at Ann Arbor that Mr. Mullett was one of the inventors of the solar compass. I have for twenty years been following in the footsteps of John Mullett in the surveys of Kalamazoo County, until his name has become as a household word to me, and if John Mullett—as I have no doubt—was a co-inventor of the solar compass it is high time he had the credit which belongs to him."

MR. FORSTER.—"I have heard it talked over many times and I know all about it from the beginning. All Mr. Mullett ever got out of it was the use of the compass; Burt did not charge him any royalty. Why should the people of the United States pay a large sum for it now, as they are asked to do? I do not see any sense in it. In fact I never thought much of the solar compass, and he said the only thing gained by it was the tripod."

MR. STRONG.—"I understand the claim on the part of the Burts is for the use of the compass by the Government Surveyors, and that at the request of the agents of the Government, Mr. Burt deferred his claim with the understanding that compensation would some time be voted him by Congress."

MR. FORSTER.—"The men who used the compasses bought and paid for them themselves. Why should Burt come in with this large claim and not others?"

MR. PEARSON.—"I am told that the Government gave Mr. Burt $20,000 outright."

MR. HODGMAN.—"I heard Mr. Burt present the matter to the Society at Ann Arbor. As I understood it he did not claim but what his uncle had received a patent, but that it was so long before the instrument came into general use, that he got but slight remuneration from it; and that when he applied for an extension of the patent, for some reason he failed to get a re-issue; I think he said because of the influence of the Government officers against it."

Surveying in Florida.

BY S. C. HODGMAN.

There is many a slip between the cup and the lip, and expectations are frequently raised that are never realized; and this may be one of the occasions. As my home is in the "Sunny Land of Flowers," its influence might, perhaps, be expected to pervade this paper, but you may find that there is something here besides sun and flowers, and if some of you were called on to disentangle some of the webs of Uncle Sam's trusted servants, you might possibly think words — I know you would not utter them — strongly flavored with brimstone, as most of the water in the *deep* wells of this country are.

Florida is quite generally in the North supposed to be a vast swamp, with here and there an island of sand, of which occasional glimpses could be had when the mosquitoes and alligators happen to open their ranks wide enough to admit the light. It is true that there are extensive swamps, saw-grass marshes, wet prairies and lakes, but the alligators are not so plenty but that a person may travel for days through the woods without even seeing one. Some description of the country may be of interest and I will confine myself to that part with which I am best acquainted — the northeastern part of Polk County. In general it may be described as a sandy ridge or succession of ridges extending from the region of Lake Apopka, nearly south, and ending near Lake Istokpoga — about 100 miles. This ridge, at Haines City, lies from 150 to 225 feet above tide water and is drained toward the east and south by the Kissimmee river and its tributaries, the water in this direction finding its way into the Gulf by way of Lake Okeechobee and the Caloosahatchee river; towards the southwest by Peace creek or river, which also enters the Gulf through Charlotte Harbor; and towards the north by the Palatlakaha into the St. John's river and Atlantic; northwest by the Withlacoochee, entering the Gulf direct. In places this ridge broadens out into table-lands which are tolerably level and sometimes quite extensive. The highlands are generally covered with a more or less heavy growth of yellow pine, interspersed with live oak, black jack, turkey and willow oaks, persimmon, etc. The highlands are generally shaded off towards the water courses by "flat-woods," which are mainly covered with pine, and "high hammocks," which have a very dense growth of oak, hickory, palmetto, and many other varieties of trees interlaced with a great variety of vines and festooned with long pendants of Spanish moss, which also drapes the pines on moist land or near the water. The low hammocks come next and are a terror to surveyors, as a track must be cut through *wide* enough, *high* enough and *low* enough to pass through. They are partly covered with water in the rainy season. Then follow the gum and cypress swamps, bay galls, bay heads, fern ponds, grass ponds, open

ponds, lily ponds, saw-grass marshes and other varieties of marshes and open lakes, of which there are very many, most of them of clear and very pure soft water. Some of the lakes have bold, sandy banks, but most of them are partly or wholly encircled by a belt of saw-grass, which grows in water from a few inches to three or four feet deep and is generally very difficult to force a passage through. Its leaves form a dense mass from three to ten feet high and are about half an inch wide — very stiff, and armed with a saw on each edge and on the mid-rib about the fineness of an ordinary saw-file and when carelessly drawn across one's hand cuts to the bone as readily as a razor. Many of the lakes are also bordered, for long distances, with a dense growth of small bay-trees and myrtle bushes which extend to about three feet depth of water and which, together with the saw-grass, renders anything like an accurate survey of their margins exceedingly difficult in the ordinary way. Nearly all the bodies of water and wet lands are bordered by what is here called scrub, from a few feet to several rods wide and extending from the water's edge back to the higher land. This scrub is a dense growth of saw-palmetto, from a few inches to several feet in height and frequently thickly interspersed with huckleberry and gallberry bushes and sometimes catbriars or brambles, so thickly that it is next to impossible to force one's way through them. A Michigan cedar thicket, bad as it is, can be discounted several times over by some of our Florida thickets. It is hardly to be wondered at that so few lakes in Florida are meandered, with so many difficulties in the way. It is quite a common occurrence to find lakes of several hundred acres that do not appear on the Government plats at all. Two lakes, partly in Haines City, of about two hundred acres each, are not meandered and are shown on the plats as small ponds. The adjacent land owners have paid for the beds of the lakes, in some instances having less than half an acre of dry land on a forty. The saw-grass marshes and most of the shallow ponds are easily drained and when dry are of the very highest grade of fertility. The drainage must, however, be on a large scale, but would cost, as a whole, but a few cents per acre of reclaimed land, as in this vicinity they lie about 150 feet above tide-water and need but little work aside from opening and deepening the main channels a few miles below.

I have found one line in this region properly marked — the line between townships twenty-seven and twenty-eight south. It is known as "Washington parallel," and extends from Bay St. Joseph on the gulf to the Atlantic and was run by Henry Washington in 1843 and complies with instructions, except as to station trees, of which there are none noted or marked. I have found this line well blazed and measurements very accurate. This is a correction parallel and the lines close on it from the north and start from it on the south.

The original surveys seem to have conformed to no particular rule of advance. In the subdivision of townships, some began on the range

line at the corner to sections 1 and 12 and run off the north tier first and so on through the town, closing on the south and west. Others began at some other point and worked the way that, probably, seemed most convenient to them at the time. The marks on the lines are very difficult to trace, no blazes being made except on what are called "fore and aft" trees, that is trees directly on the line. All others are marked with single horizontal cuts of the axe at the usual hight of blazes. On section lines there are two cuts and on range and township lines three about six inches apart and directly facing the lines. At the present time many of these marks are oblitirated by the growth of the trees and others are almost invisible, entirely so on some east and west lines, and on such the quarter posts are generally invisible also. I have, as yet, been unable to find a single "traverse" post called for by the field notes. Except on the Washington parallel, I have not yet seen on any of the U. S. surveys a marked bearing tree; even the size is not given in the notes so that if the post is gone they cannot be identified and even with the post in place the courses and distances to many of them are not even approximations. It is quite common to find posts standing with two or four bearing trees noted where no trees now stand and with not the least trace of having ever stood; others with no posts visible and the point for the post falling in a thick clump of trees with the notes calling for bearing trees one to three chains distant. A great latitude must have been given to distances to bearing trees, as, in some townships, they all have 5 or zero as the final figure. The variation of the needle is rarely given, and I have as yet been unable to find that the course of one line was a very good guide to that of another supposed to be parallel with it. It also sometimes happened that, in recording the notes of the days work at night, queer transpositions were made and lines that run wholly in water from one to six feet deep would appear as high pine land, and vice versa.

There is one redeeming feature in these surveys. The posts are generally of durable material, especially on the pine lands, being made of "lightwood" which is the pine which has stood or laid for years until the sapwood has decayed and worn away and left nothing but the heart wood which is highly resinous and very heavy, and almost as durable as red cedar. Most of the posts on the Washington parallel are still in place and the marks plain after standing over forty years, and they seem good for many more years of service.

In regard to the labor of running lines here much depends on circumstances. In the pine woods there is usually but little undergrowth, sometimes hardly a bush in a mile. At other times one may be fortunate enough to strike a large number of trees in half that distance. I have run and corrected five and a half miles a day with one axeman in level pine woods and I have worked hard with two axemen on half a mile of gum and bay swamp for a day and a half. Much of the way a man could not be seen fifteen feet ahead.

It quite frequently happens here that a surveyor is thrown on his own resources as to the proper position of a corner post. I have found cases where all marks of the U. S. survey, except blazed or hacked trees, were missing, and a measure could only be taken from one direction. In such cases I placed the post at the intersection of the blazed lines. In one case the notes called for the line from the south over high pine land, when in fact the last half mile was in water two to six feet deep and was evidently fraudulent. It frequently happens that, while the land to be surveyed is mainly dry, the lines will run a large part of the distance in water and with no chance to get around it with any reasonable amount of labor and time. So long as it can be waded we cut some long "tally pins" and in we go. Wetting never hurts any one here but it is not always pleasant to be burdened with wet clothing, especially if one has to camp out and sleep, or try to, with them on. Boots and good clothing are at a discount here, in the field. The saw-palmetto, catbriars and saw-grass will soon ruin the clothing and it is inconvenient pouring the water out of the boots sometimes.

One peculiarity of this country is the difficulty of keeping a direct course in the woods without very frequent reference to a compass. During a great part of the year the sun is so nearly vertical that it is impossible, unless one knows the exact time of day, to tell for several hours in the middle of the day whether it is east, south or west of the observer. I have seen it shining on the water at the bottom of a forty-foot well, through a central opening of twenty inches square at the top. If one is trying to trace a line and has a tree in the distance as an object, unless it has some very marked peculiarity, he must keep his eye on it constantly. If he allows his eye to wander, even for a moment, he is almost certain to lose his object, as all look so much alike, and unless he has a very strong personal sense of direction his course is lost and he must refer to his compass again.

We have some annoyance from insects, but not so much as in Northern Michigan. Mosquitoes do not trouble one in the daytime but in some localities are quite troublesome at night, and a mosquito-bar in one of the necessities of the outfit of a "camper out" for a large portion of the year. In the summer and fall the low hammocks and grass and bushes near the water are infested with a microscopic insect called the redbug. It is only visible to the naked eye as a minute, red point, but he will cause a large amount of scratching to the square inch, and manages to make his presence distinctly known about bed-time, and from that until morning. Remedy, grease of any kind, strong soap suds, kerosene, strong salt water or turpentine. In the winter we have myriads of seed-ticks on the grass and bushes, and they sometimes swarm on the clothing and on the person but do no harm beyond the irritation caused by their crawling about. One can remove them, if he wishes to, one at a time. They are very small, about as large as the diameter of a No. 1 sewing

needle. This is supposed to be a great country for poisonous snakes, but I have seen scarcely any since I came to the State. I have killed two or three "ground rattlers" about fifteen inches long. I have seen one '*Crotalus horridus*," a captive, caught several miles from here, and one large moccasin was killed on one of my trips two years ago. I have not known of any one being bitten by them since I came here. We have a few huge black snakes and gopher snakes, but they are harmless. Sometimes, if one is a little incautious in handling wood with loose bark on it, or partly decayed wood, he may be sharply reminded that a scorpion has pre-empted that particular spot. Their sting, however, is not as painful or as lasting as that of a bee or wasp, although quite sharp at first. There are several varieties of stinging ants, mostly quite small. One, however, called the "cow-killer," is about as large as a honey-bee, and is armed with a curved sting nearly or quite half an inch long. Their sting is said to be terribly painful and lasting, but I have never tried it or known any one who had. They are rarely, if ever, seen except on the ground, and never meddle with any one who lets them alone.

During the summer the temperature rarely rises above 90°. During the middle of the day it is quite hot in the sunshine but quite pleasant in the shade, as there is nearly always, day or night, a breeze from the Atlantic or the gulf. Indeed it is much cooler on this peninsula of South Florida than in many of the States farther north.

If the surveyor has a taste for natural history or botany he finds here abundant opportunities for its cultivation. The swamps and hammocks are full of novelties in both animal and vegetable life, some of which I might attempt to describe, but fear that I should trespass on your time and patience.

The surveyor who corrects the errors of the original survey is still abroad and is frequently heard from. He also surveys an interior "forty" by starting from a quarter post and running 'round it — not the quarter post but the "forty."

On the whole the work is much more pleasant in this climate than in the north; wading through marshes and ponds whose waters do not chill one is much more agreeable than wading through deep snow. The mosquitoes do not bite any harder and I have never been annoyed by them while at work as I have in Northern Michigan, and there are none of those little pests — sand flies and punkies. Since coming to Florida I have never needed an overcoat while at work; have never seen the mercury below 26° or above 98° and only three or four days of either. In conclusion, gentlemen, while you are striving to keep warm by your furnaces and heaters, cast your eyes — mentally, of course — down to latitude 28° 5' and see one of your members, who would gladly meet you again, at work in his garden among his vegetables and flowers.

Memoir of John Mullett.

BY JOHN H. FORSTER.

[Written originally for the State Pioneer Society.]

James Mullett, the father of the subject of this memoir, was born in England, and came to this country with Burgoyne's army of invasion, having been seized by a press-gang in the city of London, and forced to serve King George III in the strife with his rebellious colonies. He had just completed his apprenticeship as a tailor, and was returning to his home in the country when the pitiless minions of an obstinate ministry forced him to embark on a troop-ship and sail away from his native land. From that time forth he was lost to his parents and friends. He participated in the battle of Bennington, and was taken prisoner. He escaped, but subsequently he joined the Continental Army, having no good will toward a King who had thus cruelly torn him from his home and country. After the war he settled in Vermont and married Sylvina Perry, who was a very superior woman, a descendant of the early pilgrims, and a relative of Commodore Perry, of Lake Erie fame.

John Mullett, the subject of our sketch, was born in Halifax, Windham County, Vermont, July 11th, 1786, and was the second son of James and Sylvina Mullett—one of an old-fashioned family of fourteen children. In 1807 the family moved to Genesee County, New York, and there in the dense wilderness hewed out a large farm, which has remained in the family until quite recently. To show how dense the trackless forest was, John used to state that when he and his brothers, with their axes, first entered upon the land to clear a building spot, they felled trees all day long and then returned at night to their distant camp. The next day they started out to resume their labors, but were utterly unable to find the spot where they had worked the day before, so they began anew. After some time had elapsed John left the farm and went to the village of Buffalo, at the foot of Lake Erie, where he engaged in the tailoring business, a smattering of which trade he had learned from his father during the long winter evenings spent on the isolated farm. Doubtless the industrious father and son fabricated and mended the garments of that growing family of sons. In 1814 he was married to Lucy Henry, of Coleraine, Massachusetts. This union was a very happy one. Mrs. Mullett was a true mother in Israel, a loving wife, devoted mother and sincere Christian. This pair were blessed with eleven children, five sons and six daughters. Four sons and two daughters survive; they reside in Meridian Township, Ingham County, Michigan.

In the war of 1812 John was an officer in the Buffalo Home Guards, and was present at the battle of Black Rock, which was the only fighting he did. He was a Federalist and opposed to the war, but turned out to

defend his home when invaded. Many of the advocates of the war took the field with the legend, "Liberty or death," inscribed on their hats. John Mullett used to describe, with much gusto, the conduct of these brave sons of Mars when attacked by the invading army. At the first volley they incontinently fled toward their homes in Genesee County, and as they ran pell-mell through the woods it was amusing to see the valorous heroes scrambling over logs and pushing through the underbrush with the legend always blazing in front, "Liberty or death."

In 1818 John came to Detroit and engaged in the tailoring business for a short time; but this trade was not suited to his tastes, intellect, active disposition and temperament. He had a great taste for mathematical studies, and his acquirements in those branches of human knowledge were very considerable. He became an excellent engineer and surveyor. In 1821 he was appointed, by General Cass, Surveyor of Michigan. During subsequent years he was often employed in engineering duties and in laying out streets and avenues in the rapidly extending domain of his adopted and well-beloved city of Detroit. While thus engaged he was frequently interrupted and threatened with stones and shot guns. The conservative, yet chivalrous, old Frenchmen did not want their farms ruined by having Jefferson Avenue projected through them.

In 1822 John was appointed, by Edward Tiffin, United States Deputy Surveyor and was engaged in surveying Government lands till 1849. In 1825, while surveying the township line in Eaton and Calhoun Counties, the Indians undertook to drive him and his party from the woods. They were determined that their lands should not be surveyed. A little fracas occurred near a creek in which two Indians were so badly pounded that they died shortly after, and the suryeying party left the woods. The stream has been called Battle Creek ever since. From 1831 to 1834, Mr. Mullett was engaged in surveying in Wisconsin. He surveyed all south of Fox and Wisconsin rivers, and was driven out by the Indians during the Black Hawk war. He was employed by General Scott to go East and purchase wagons for the transportation of troops.

He surveyed the road from Pontiac to Saginaw in 1822. He located the University lands in 1830. He likewise surveyed the town line from the meridian line to Lake Michigan, south of the base line, and subdivided into sections large portions of both Peninsulas. He surveyed private claims at Green Bay and Mackinaw, and laid out many towns and villages in Michigan and Wisconsin. Mr. Mullett was a charter member of the Detroit Lodge of Free Masons and was its first Master. He was the second Grand Master of the Michigan Grand Lodge.

In 1853 he removed to Meridian Township, Ingham County, where, after an illness of several years, occasioned by paralysis, he died January 10, 1862, aged seventy-five and one-half years. His remains lie in the little rural cemetery near the village of Okemos, Ingham County. John's

brothers were men of ability, but only two of them were conspicuous in public life. Ernest Mullett was a sound lawyer, who died at Dunkirk, New York. James Mullett resided for many years in Fredonia and Buffalo, New York. He was a very learned, able lawyer, a most eloquent advocate and orator, and a sound jurist. For many years before his death he was one of the Judges of the Supreme Court of the State of New York.

In person John Mullett was rather tall, lithe and active, full of genial *bonhomie*. He possessed an inexhaustible fund of anecdote and humor, which made him the life of every company he was in. Like our lamented President Lincoln, he always had a story to tell apropos to everything, and no one excelled him as a story-teller. His intellect was keen and incisive. He had a great mechanical genius. He was well informed and full of pioneer lore. In Detroit he numbered among his warmest friends most of the leading, distinguished men of his generation. He was very domestic in his tastes, and he loved his own fire-side, with his wife and children gathered around it, better than anything else in the world; very courteous in his manners at home or abroad, he was a pleasant gentleman of the old school. As before stated, he was an able mathematician, a thorough master of his profession in his day. He was as modest as he was able. He was kind, honest and honorable in his intercourse with his fellow-men.

With all the great advantages which his profession of surveyor and his intimate knowledge of the great Northwest afforded him, Mr. Mullett only succeeded in securing a moderate competency. At one time he owned a great deal of property in Detroit and elsewhere, but while real estate in his day was not exempt from taxation, it enjoyed no corresponding *boom* in price. Had he been able to have held on to his real estate a quarter of a century longer he would have died a millionaire. Moreover, his modest disposition prevented his reaping honors that were justly his due.

PRESIDENT STEELE.—"I do not know as you enjoy these reminiscences as I do, but I think that our Society ought to have more of them. We have a great many things in relation to the history of our State in the line of Engineering that ought to be brought forward. Mr. Teed has something he wishes to say in regard to steel tapes."

MR. TEED.—"Last summer I had an opportunity to compare the lengths of steel tapes. There were two Gurleys, two Hodgmans, one Excelsior and one I have forgotten what. The two Hodgman tapes agreed exactly in total length and in all their subdivisions. Each ten feet was a tenth of the hundred and each fifty was one-half of a hundred. The other four tapes agreed with themselves and in their subdivisions, but they did not agree with the Hodgman. The Hodgman tapes were almost exactly four one-hundredths shorter than the others. Now if the Hodgman tapes are all half an inch too short it ought to be known, and if occasionally one is too short that ought to be known. It might sometime get us into a very embarrassing position, supposing we had a perfect standard of measure when we had not."

MR. STEELE.—"I think that question could be settled by the apparatus in the University, prepared under the direction of Prof. Davis. They have a trestle 100 feet long, graduated from the standard, which I donated to them. I think the only charge is just enough to cover the expenses. As far as these observations go they only prove a discrepancy. They do not prove the Hodgman tape too short. You can not assume that because four tapes are of a length and one short that the one was wrong. Sometimes noses count and sometimes they don't. It sometimes depends on the length, whose it is, and so on."

MR. HODGMAN.—"Carrying out our President's suggestion of sending tapes to Ann Arbor for testing might not always prove satisfactory. So long as the Hodgman tape was manufactured by my brother it was graduated from the same standard as the trestle in the University was, so it might not prove anything."

MR. APPLETON.—"I understood Mr. Steele a few years ago to state that the Hodgman tape was graduated from the United States Standard in his office."

MR. STEELE.—"Mr. Hodgman and I wanted to make some tapes. I had a standard rod that I had procured from Prof. Hilgard of the Coast Survey. It came with the rate of expansion marked on it with a stamp and its exact length at a certain temperature, and also a certificate that it had been compared and was correct. It was at the time the very best thing that could be obtained. It was at the time the only one in the State of Michigan, I presume. I said, 'The best way we can get at it is to make a trestle, or something, and measure off a hundred feet on it with

this standard and from that make our tapes.' From that Mr. Hodgman made quite a number of tapes and sold them. He had a shop and a place where he made them all alike, but he found that the rod that I had was not so good a standard to compare his tapes by as it was to take a piece of the same material and cut it off the same length as the standard and compare his tapes by that piece. The temperature affected the thin strip in a different way than it did the rod; so he got in the habit of using this short piece of steel tape, which was an absolute duplicate in length of my rod, and from that made all his tapes while he was in Traverse City. The only advantage in sending to the University is, I suppose, they have the best kind of a trestle for comparing lengths of 100 feet."

MR. HODGMAN.—"The University folks made that trestle from the same standard rod that my brother made his tapes from — the one Mr. Steele gave them."

MR. TEED.—"Which tapes were right and which wrong, or if all were wrong, is something I think we ought to know more about."

MR. RIPLEY.—"The best standard in the United States is a metre, and it is in the Engineer's office at Detroit at the present time."

MR. HODGMAN.—"Will steel tapes lengthen by use? I have seen some things which led me to suspect that it had happened."

MR. STEELE.—"I notice in Mr. Johnson's work that he recommends very small, long tapes for base measurements."

MR. HODGMAN.—"Mr. Benton says, on page 372 of "Johnson's Surveying, 'If a man compares steel tapes bearing the brand of the same manufacturer and sold in the same shop, he soon ceases to be surprised at a very appreciable difference in length.' Prof. Johnson also says, page 455, that 'all the so-called standards are more or less discrepant on coming from the makers.'"

The paper by Prof. Carpenter was then read by the Secretary.

Heating by Hot Water.

BY R. C. CARPENTER.

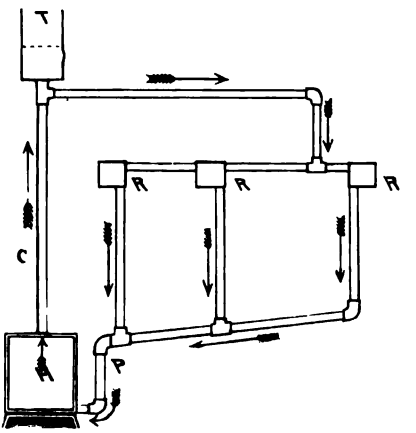
The systems in use for warming residences are of two distinct classes, the first and older utilizes the heat near its source and uses only the direct heat of radiation, no attempt being made for the especial conduction of heat; the second attempts to produce the heat at some one point and to conduct it by some means to the place where wanted.

In the first class we find the old-fashioned fire-place, with its excessive ventilation, and the modern stove with no ventilation at all.

In the second class we find the hot-air furnace, but water heaters and steam heaters.

With the hot-air furnace the attempt is made to draw the pure air from outside over a heated surface and then distribute it, by the natural currents which result from heating, to the various places where wanted. This method of heating, unless extraordinary precautions be taken, which cannot be discussed here, is anything but positive. The hot-air currents are affected to a great extent by external conditions of the atmosphere. A heavy wind pressure on one side of the house may over-balance all the force obtained by expanding the air by heat, and this is especially likely to happen if the horizontal distance from the furnace is great; the consequence is, that often heat will not go where wanted. I have even seen, in well-constructed furnaces, an inverse current proceeding from the rooms over the heated furnace and passing outside. These conditions, which are just as hard to remedy as a smoky chimney, tend to make the hot-air furnace anything but a positive heater under usual conditions. Again, the heat from the hot-air furnace is likely to be carried by excessively dry air, which absorbs moisture from the room, leaving a painful sensation, difficult to describe, but which frequently brings on severe headaches. It is true this last condition may be easily remedied, but it is also equally true that it usually exists as described.

In England the method of heating by hot air was followed by a system of hot-water heating, in which the water is heated in a furnace and carried by a pipe leading upward, or to the rooms where heat is needed, from the upper portion of the furnace; the water descends through a return pipe, leading to the lower portion of the furnace. It is, perhaps, needless to say that these pipes are connected and form, with the furnace, a closed system. The pressure on the furnace is that due simply to the height of the column of water, and is practically always the same, regardless of the temperature of the water. The principle will be made



clear by considering the diagram. H is the heater, which is connected in the upper part with pipe C, and at the lower part with the pipe P. T is a small tank, open at the top, of sufficient capacity that, although the water shall always stand above the pipe P, yet when the water is heated, it shall not overflow. R R R are radiating surfaces to heat rooms. The course of the circulation is as follows: The water, heated by the furnace H, ascends the pipe C, from the simple fact that the hot water has less weight than the cold water, and it is replaced by cold water coming from the pipe P, entering the bottom of the heater. The circulation, then, is due to the fact that the hot water in the ascending pipe C, is lighter than the corresponding height of water in the pipe P, and this is true regardless of the respective sizes of the pipe C or of the pipe P; it is also true regardless of the horizontal distances traversed by each of these pipes, unless one or the other travels so far as to make friction an important element, because of the fact that hydrostatic pressure depends simply on the height of the water column, regardless of its volume. The rapidity of circulation will depend on the difference of weights of the columns of hot and cold water, and this again will depend on the difference of temperature and on the height to which the pipes rise. The less the amount of friction, the stronger the circulation will be.

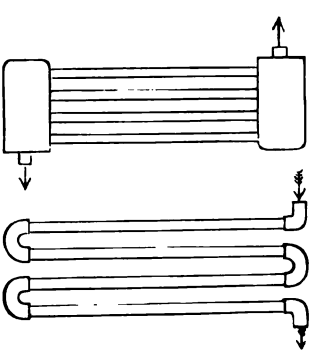
The English method of hot-water heating employed pipes four inches in diameter, and consequently was not only costly, but had an unsightly appearance. This system has been used in this country only to a limited extent, and that principally for the heating of green-houses.

Heating with low-pressure steam is very common in this country and until within the past few years it has been regarded as being the most desirable of all methods of heating. Steam heating has been perfected in nearly all its details. In the best systems there is little for the house-owner to do, except to maintain the supply of coal in the magazine of the furnace. An automatic device feeds water when needed, another shuts off or lets on the draught as the pressure of steam gets too great or too small. Automatic air-valves on the radiators lets out the cold air when steam is turned on. Yet, despite all these perfections, there are some inherent defects in the nature of the fluid used for conveying heat, which

prevent this method attaining absolute perfection. It is this, and it is a serious objection, too. There is no intermediate stage of heating by steam — the heat is either all on or all off. This arises from the fact that the temperature of steam is nearly the same at all pressures, so that if there is any steam at all the heat is nearly as great as though there was a full pressure. This fact explains why we so often get excessive heat from a steam-heating apparatus, and also the loss of economy due to supplying more heat than is needed. The principal objection to the steam-heating apparatus is that the heat cannot be regulated in temperature by firing, or by any automatic method.

It has been shown that the objections to the old method of hot-water heating is due principally to the excessive cost and to the cumbrous size of the pipes used. The practice of using small pipes for hot-water heating was started perhaps ten years ago, and, strange to say, the results have been uniformly good, and perhaps in all respects superior to steam. The radiating pipes are now usually one and one-fourth inch, internal diameter, and can be arranged like steam-pipes by putting directly in the room to be heated, or at the bottom of air passages leading to the rooms. The pipes may also be arranged vertically in radiators that appear much like steam-radiators; but in the case of hot-water heating, the hottest water must be discharged at the top of the radiator and the coldest water discharged from the bottom. The radiator must be arranged so as to secure a current through each pipe of the radiator. The most successful radiating surface is a manifold coil, the hot water being supplied at one end and the cold passing out at the other. The *return bend* coil is by many considered superior to the *manifold* coil, but in practice it is not nearly so good; air very often gathers in the return bends, and in such a case the circulation is entirely interrupted until the air is removed. In putting in systems of hot-water heating, care must be taken to reduce the friction to a minimum in the circulating pipes. This is done by avoiding right angle turns of short radius and by the use of valves that obstruct the flow but little. The pipes which return the cooler water to the boiler should run as direct as possible, and should always slope toward the boiler as much as possible. As compared with steam, hot-water heating affords advantages of a more uniform heat, and a graded heat to suit the weather; the apparatus is less likely to leak and is more durable. Its first cost is about twice that of a hot-air furnace and somewhat more than a steam-heating apparatus.

MANIFOLD COIL.



RETURN BEND.

It requires, on the average, about twice as much heating surface as in steam-heating, or one foot of heating surface to from forty to one hundred cubic feet in the room. The cost of hot-water heater is much less than that of steam boiler, although the radiating surface costs more.

No discussion.

MR. STEELE.—"We have an hour before noon, and having promised to visit the Asylum this afternoon, we had better encroach on the afternoon programme by hearing Mr. Gillette's paper."

The Seneca River Bridge.

(New York Central & Hudson River Railroad.)

BY O. C. GILLETTE.

The Seneca river is the outlet of that remarkable chain of lakes situated in the central part of the State of New York. The New York Central & Hudson River railroad crosses this river at the Montezuma marsh, between the villages of Port Byron and Savannah, about fifty miles east of the city of Rochester.

The river at the place selected for crossing spreads out to a width of nearly two thousand feet, and is four or five feet deep. The current, as might be expected, is quite sluggish. The bottom is composed of an exceedingly thin muck, into which a sounding rod was driven to a depth of ninety feet—a not very substantial support for all the tons of stone and iron which compose the structure of a railroad bridge.

The subject of foundations is justly regarded as of the highest importance to the Engineer. Many a structure, otherwise well built, has failed through ignorance or lack of care in the foundation. Solid rock is regarded as the best foundation for heavy structures; but rock is not always without its difficulties. Recall the Eddystone light-house and the obstacles encountered in rearing that structure on the sloping surface of the rock on which it is built. The most obvious treatment of such sloping rock surfaces is to cut them into steps or to bring them up level by means of concrete deposited in layers of eight or ten inches and thoroughly rammed until the mortar flushes out on the surface. It should be allowed to stand at least over night and become thoroughly set before any weight is placed upon it. I have used this last method with perfect success under one of the heavy masonry piers of a double-track railroad bridge. Sometimes fissures are met with in rock, which require either to be filled or to be arched over. Again, veins of water cause trouble. Sometimes these may be stopped out with cement, or they may be led out through channels in the masonry and left to flow.

On one occasion, on excavating the foundation pit for an abutment, I found it to be located right over the spring which supplied a creamery. I left a culvert in the masonry and so prevented the water from damming up and injuring the structure, and also saved a lawsuit for damages for diverting a water course.

Often it is thought advisable to go to great depths for the sake of a solid foundation. The foundations of some of the piers of the Rondout viaduct on the New York, West Shore & Buffalo railway are situated more than a hundred feet below the surface of the hillside. When rock cannot be reached, the usual method is to drive piles, and, if there is to be a masonry superstructure, a grillage and platform is framed onto the piles. Within sight of the Seneca river bridge the Erie canal is carried across this same Montezuma marsh by a stone aqueduct, about 900 feet long, resting on a pile foundation. There were 110,000 lineal feet of piles used in this structure.

The consideration of the load that a pile will bear, as deduced from the amount of its sinking under a given weight and fall of hammer, presents an interesting field for discussion, which I must entirely pass by. When the soil is quite firm and the structure not too heavy, the piles may be omitted and the platform alone used, especially if it is in a location where it will always be kept wet. Often nothing more is required than to make the footing course broad and of large, flat stones, so as to spread the weight of the structure over as large a space as possible.

In the case of the Seneca river bridge, which I wish particularly to describe, the following course was adopted: A dredge was brought to the place and the bottom was dredged off quite smooth. When about 200 feet in length had been thus prepared, the platform was commenced. This platform, which is 1,800 feet long and forty feet wide, is composed of timbers, each thirty-eight feet long and twelve inches thick, halved onto each other and secured by seven-eighths inch bolts. They are laid close together and so as to break joints every eighteen feet, or at the centers of the piers. They are held laterally by the bottom timbers of the cribs, which extend entirely across the platform, and are bolted to each timber with three-fourths inch rag bolts, twenty inches long. The cribs are composed of courses of ten by twelve inch hemlock timber, tied together by six by eight inch oak ties dove-tailed into the side timbers. The timbers of the cribs were fastened by three-fourths inch rag bolts, twenty inches long. The cribs were filled with loose stone, which caused the platform to sink onto the bed prepared for it. The cribs were covered across the top with squared hemlock timber, six inches thick, rag-bolted to the top course. The building of the platform and cribs was carried forward from one end at the same time as the excavation. The top of the cribs is a little below the surface of low water. On the cribs were built piers of masonry, which support the iron bridge girders. These girders are the ordinary plate-iron riveted girders and are placed under

the rails. The masonry is rock-faced Ashlar, with the edges pitched to straight lines, with no projections of more than two inches. The beds are bush-hammered sixteen inches back and the end joints ten inches. Each course bonds twelve inches with contiguous courses. There is a header to every two stretchers. The headers, when possible, are four feet long, and the stretchers two feet wide. The piers are finished at top with a coping. It is an interesting question whether or not the span adopted was the most economical. The differential calculus, that good genius of the mathematician, stands ready to answer the question.

It is required that the cost of the piers added to the cost of the girders shall be a minimum. The number of piers is evidently a function of the span. The cost of a single pier is readily computed. It has been shown that, up to a limit of about 200 feet, the cost of iron girders varies as the square of the span. So from the cost of a known girder we can deduce the cost of the required girder in terms of the variable quantity. We then have all the quantities necessary for the computation.

With the cost of material at the time this bridge was built, I computed the economical span to be about forty feet But as often happens, practical considerations must govern. It is necessary that the weight should be distributed over the platform as uniformly as possible.

I have presented this structure for your consideration, not because it displays any new or very remarkable principles of construction, but as an example of that perfect adaptation of means to ends which is one of the glories of modern engineering science.

No discussion.

The Secretary then read letters from prominent Engineers in Boston, Philadelphia, Chicago, Washington, Hew Haven, and Burlington, Iowa, on accurate measurements for city surveying and monuments for street lines, containing information designed for use in the next edition of the Manual of Land Surveying.

The report of the Executive Committee was then taken from the table and adopted.

Report of Executive Committee.

KALAMAZOO, Jan. 19, 1888.

MR. PRESIDENT AND GENTLEMEN:—The Executive Committee beg leave to submit its annual report as follows:

In obedience to a call of the President a meeting of the Executive Committee was held in the City Engineer's office, Lansing, the 12th of October, 1887, in connection with a general meeting of the members of the Society, to adopt articles of incorporation as provided for by act of the last Legislature.

The members of the committee present were the President, George E. Steele, Secretary, F. Hodgman, and Chairman, M. E. Cooley. The date of the Kalamazoo meeting was fixed for January 17, 18, 19 and 20, 1888, and a programme prepared as far as possible, the Secretary being instructed to complete it and send to members with the announcement at the proper time. A copy of the announcement and programme is hereby attached.

PROGRAMME AND ANNOUNCEMENT.

You are cordially invited to attend and take part in the Ninth Annual Convention of the Michigan Engineering Society, to be held in Kalamazoo, January 17, 18, 19 and 20, 1888, and bring with you any Surveyor or Civil Engineer of your acquaintance.

The accompanying certificate, if properly filled out by the Station Agent at your starting point, and by the Secretary of the Society at Kalamazoo, will entitle you to return over the same route at one-third fare, over any railway in the Michigan Railway Association. Read the certificate carefully and see that it is properly filled out. If you wish for more certificates for friends, write to me for them immediately.

OFFICERS.

PRESIDENT—Geo. E. Steele, Traverse City.
VICE-PRESIDENT—E. F. Guild, East Saginaw.
SECRETARY AND TREASURER—F. Hodgman, Climax.
EXECUTIVE COMMITTEE—M. E Cooley, H A. Collar, A. L. Drew.

STANDING COMMITTEES.

Manual—F. Hodgman, C. F. R. Bellows.
Land Surveying—I. H. Leavenworth, A. J. Teed, C. E. Hollister.
City Surveying—Geo. S. Pierson, J. J. Granville, William Appleton.
Railroad and Bridge Engineering—A. L. Reed, G. Stewart Johnson.
Mechanical Engineering—Jesse Smith, R. C. Carpenter, C. G. Taylor.

Hydraulic and Mining Engineering—C. D. Lawton, Frank P. Mills, H. B. Sturdevant.

Sanitary and Drainage Engineering—A. C. Sekell, S. N. Beden, M. H. Bailey.

Rivers, Harbors and Light Houses—J. A. Mitchell, Joseph Ripley, B. H. Muehle.

Highways and Highway Bridges—William B. Sears, Wm. P. Innes, Burton Kent.

State Boundary—George A. Marks, J. K. Yocum.

National Public Works—J. B. Davis, R. C. Carpenter, Wm. B. Sears.

Land Laws and Decisions—Wm. Appleton, D. Skeels, M. H. Bailey.

Preliminary to the Convention, the members of the new Society, incorporated under the act of 1887, will meet at the American House, in Kalamazoo, at 10 o'clock A. M., January 17, 1888, adopt Constitution and elect officers, as provided by the act, after which they will be prepared to receive members and complete the transformation of the old into the new Michigan Engineering Society, directed by the Society at the Grand Rapids meeting. This will be an excellent opportunity for new members to join.

The headquarters of the Society during the meeting will be at the American House, near the G. R. & I. depot. The Convention will be held at the Court House.

HOTEL RATES.

American House (special), $1.50.

Burdick House and Kalamazoo House, $2.00.

PROGRAMME.

Tuesday, January 17, 2:00 P. M.

Reports of Officers and Committees in their order.

Admission of Members to new Society.

Paper, "Stray Thoughts of an Engineer in Cross Section and Profile;" Wm. Appleton, City Engineer, Lansing.

Evening.

Address by the President, Geo. E. Steele, Traverse City.

Paper, "Heating Residences with Hot Water;" Prof. R. C. Carpenter, Agricultural College, Lansing.

Paper, "Highway Bridges;" Prof. C. E. Greene, University of Michigan, Ann Arbor.

Wednesday, January 18, 9:00 A. M.

Appointment of Committees.

Paper, "Village Plats;" Prof. R. C. Carpenter.

Paper, "Village Plats;" J. E. Sherman, Marquette.

Paper, "Map Drawing;" Prof. C. S. Denison, University of Michigan, Ann Arbor.

Jottings, Questions, etc.

Afternoon.

Paper, "History of Portage Lake and Lake Superior Canal;" J. H. Forster, formerly State Engineer in charge, Williamston.

Paper, "Improvement of the Middle Neebish Channel;" Joseph Ripley, U. S. Engineer, Sault Ste. Marie.

Paper, "Plane Table Surveying;" Prof. J. B. Davis, University of Michigan, Ann Arbor.

Evening.

Plain supper and social at the American House.

Thursday, January 19, 9:00 A. M.

Paper, "What a Special Agent Saw in Oregon and Nebraska;" Isaac Teller, U. S. Deputy Surveyor. Cohoctah.

Paper, "Surveying in Florida;" S. C. Hodgman, C. E., Haines City, Florida.

Paper, "The Invention of the Solar Compass;" J. H. Mullett, Surveyor, Williamston.

Paper, "Reminiscences of John Mullett;" J. H. Forster, Williamston.

Afternoon.

Business.

Paper, "Combination Bids;" Prof. J. B. Davis, Ann Arbor.

Paper, "Economic Location and Construction of Railways;" Edw. Barrington, Chief Engineer Pacific Railway in Nebraska, Superior, Neb.

Paper, "Some Difficult Railway Foundations;" O. C. Gillette, C. E., Traverse City, Mich.

Paper, "Michigan Railroads in 1887;" A. L. Reed, Chief Engineer Pt. Huron & Northwestern R. R., Port Huron.

Evening.

Paper, "Sources of Error in the Gradienter;" H. C. Pearsons, C. E., Ferrysburg.

Remarks of Instrument Makers.

Paper, "Underground Channels of Water;" W. R. Coats, Hydraulic Engineer, Kalamazoo.

Reports of Committees.

Friday, January 20.

Visits to points of interest in the vicinity.

Articles of Association having been prepared and signed by the members present, a rough draft of a Constitution and By-Laws was also prepared and referred to the Executive Committee for final preparation, preparatory to submitting to the Convention at the Kalamazoo meeting.

Notice having been given in the preliminary announcement a meeting of the charter members was called at the American House, Kalamazoo, at 10 A. M., Jan. 17, 1888, to receive report of committee and adopt Constitution and By-Laws. No quorum being present, a second meeting was called at the American House January 18, at 9 P. M., when the report was received and the Constitution and By-Laws discussed at length, the matter being disposed of as far as this committee is concerned.

The committee further report that the following applications for membership have been received and duly acted upon: Jas. L. Callard, recommended by Jas. Ripley, B. H. Muehle; H. C. Chapin, recommended by S. S. Hastings; W. M. Judd, recommended by Geo. S. Pierson, F. Hodgman; Wm. J. Kirby, recommended by F. Hodgman, Geo. S. Pierson; C. Y. Dixon, recommended by C. E. Greene, M. E. Cooley; Patrick O'Connell, recommended by Geo. E. Steele, Wm. Appleton; W. F. Durand, recommended by M. E. Cooley, John H. Forster.

This committee would recommend and urge upon the Society the importance of suggesting at this meeting subjects of papers for our next meeting, and calling upon members for papers upon particular subjects. There are many advantages in having a list of subjects and topics which may be consulted in preparing papers. It is the practice of some of the American Societies to publish a list of topics in the announcement, to be considered in convention. Much valuable information and experience is by this means brought out, which forms a valuable addition to the regular papers published in the proceedings.

M. E. COOLEY,
ALBERT L. DREW.

SUPPLEMENTARY REPORT OF EXECUTIVE COMMITTEE.

KALAMAZOO, Jan. 19, 1888.

MR. PRESIDENT:—The report of the Secretary and Treasurer, which was referred to the Executive Committee, is hereby reported back, as follows: The report but partially expresses the work which our Secretary has had to perform the past year in straightening out the affairs of this Society, which were in such chaotic condition one year ago. This Society is largely indebted to the efforts of our Secretary for the very satisfactory condition in which we now find our business matters. This committee ventures to express the hope that we may before long make the office of Secretary that of a paid officer, as a large amount of time is necessarily taken in publishing the proceedings, to say nothing of the time required to attend to routine business.

In the matter of exchanges, while it would seem that the size of our Proceedings and the membership of this Society would entitle us to some consideration on the part of other Societies, yet we do not believe that our best interests will be subserved in insisting that our sister Societies shall furnish us two copies of their Proceedings for one of ours; nor will it show as markedly the brotherly spirit which should, in the interests of our profession, exist among State Engineers' Societies. We suggest that our Secretary be instructed as before to make the best arrangement possible, in the expectation that other Societies will recognize the greater size and cost of our Proceedings, as well as the larger membership of our Society, and extend to us, as before, either two copies for one or three for two.

The Treasurer's report has been carefully examined and accounts audited and found correct. This Society is to be congratulated on the sound financial basis upon which we find ourselves in assuming the duties of an incorporated body. We recommend that the Secretary take such legal steps as may be necessary in settling with Heller & Brightly, of Philadelphia.

M. E. COOLEY,
ALBERT L. DREW.

The question of the adoption of Constitution and By-Laws and election of officers of the new Society was discussed, but there being only five of the ten incorporators present, it was thought best to postpone any action till advice could be taken in regard to the legal right of that number to act for the Society. The report of the Obituary Committee was read and accepted, as follows:

OBITUARY.

ROBERT EDWARD WILLIAMS, son of Thomas Scott and Ellen Goodwin Williams, was born in Newton, Mass., January 27, 1849. He graduated at Yale, in 1871, and took up Civil Engineering as a profession, and, after two years' practice, entered the University of Michigan to complete his studies He graduated in 1874, with the degree of Civil Engineer, and for the next year and a half was employed at the water-works in Lawrence, Mass. He then entered the firm of Williams, Page & Co., of Boston, dealers in Railroad Supplies, with which he was connected about six years. He was married April 26, 1877, to Miss Helen E., daughter of Hon. W. L. Seaton, of Jackson, Mich., and made that place his residence during his later years. While engaged as Superintendent of the Construction of Water-works in Rochester, Minn., in 1886–7, his health failed and he was obliged to resign.

The immediate cause of his death, which occurred May 16, 1887, was congestion of the lungs. His wife, one son and one daughter survive him.

THURSDAY, 4:00 P. M.

PRESIDENT STEELE.—"We will proceed to business. We have enjoyed our visit about the city, and will now listen to Mr. Reed's paper.

Engineering Work of 1887.

BY A. L. REED.

TO THE PRESIDENT AND MEMBERS OF THE MICHIGAN ENGINEERING SOCIETY—GENTLEMEN: — I had failed to realize the fact that I was chairman of the Committee on Railroad and Bridge Engineering, until my attention was called to the fact by the Secretary, and that as such I was expected to be ready with a report at the annual meeting. I at once placed myself in correspondence with the other member of the committee, Mr. Johnson, of Grand Rapids, Chief Engineer of the G. R. & I. Railroad (the third member, Mr. Robert E. Williams, of Jackson, having died in May last). I found it would be impossible to hold a meeting of the committee before the annual meeting, and Mr. Johnson advised me it would scarcely be possible for him to prepare a paper for presentation as a report, owing to the pressure of other duties. It seemed therefore to devolve upon myself to provide a paper which might at once embrace the report of the committee and present some few points of interest to the Society. I have therefore endeavored to give a brief resume of the railroad work in the United States, and in our own State, for the year, in addition to a mention of some special work in direct connection with our railways.

The present year has been one of unusual activity in all branches of engineering work, and especially so in railroad construction, the figures for the year showing a grand total of 12,724 miles of new line constructed in the United States, an excess of 1,156 miles over the year 1882, when 11,568 miles were built, and it was generally expected that these figures would never again be reached. Although statistics are usually dry matter, I think the Society will be interested in knowing where the new roads have been built, and will bear with me in reading the following statement of the number of lines and mileage of each for the year 1887:

Maine, two lines, 31 miles; New Hampshire, one line, 23 miles; Massachusetts, five lines, 55 miles; New York, six lines, 97 miles; New Jersey, two lines, 15 miles; Pennsylvania, thirteen lines, 125 miles; Maryland, one line, 18 miles; West Virginia, three lines, 58 miles; Virginia, four lines, 64 miles; North Carolina, ten lines, 184 miles; South Carolina, seven lines, 104 miles; Georgia, eight lines, 231 miles; Florida, ten lines, 193 miles; Alabama, fifteen lines, 515 miles; Mississippi, five lines, 99 miles; Louisiana, four lines, 65 miles; Tennessee, ten lines, 68 miles;

Kentucky, eight lines, 168 miles; Ohio, fourteen lines, 155 miles; Michigan, thirteen lines, 700 miles; Indiana, nine lines, 115 miles; Illinois, twelve lines, 328 miles; Wisconsin, eleven lines, 363 miles; Minnesota, nine lines, 196 miles; Dakota, seventeen lines, 760 miles; Iowa, ten lines, 352 miles; Nebraska, seventeen lines, 1,101 miles; Wyoming, three lines, 133 miles; Montana, seven lines, 616 miles; Kansas, forty-four lines, 2,070 miles; Missouri, sixteen lines, 554 miles; Indian Territory, five lines, 499 miles; Arkansas, eight lines, 153 miles; Texas, nineteen lines, 1,055 miles; Colorado, nine lines, 818 miles; New Mexico, one line, 4 miles; California, fourteen lines, 358 miles; Idaho, two lines, 54 miles; Utah, one line, 6 miles; Arizona, two lines, 70 miles; Oregon, four lines, 48 miles; Washington Territory, three lines, 108 miles; making in a total of 42 of the 47 States and Territories, 364 lines built, 12,724 miles. The only States in which no railroads were built during the year were Vermont, Connecticut, Rhode Island, Delaware and Montana. It will be seen from the above that the greater part of the increase has been in a few of the western States and Territories. Kansas leads with 2,070 miles, which is astounding when we stop to consider the labor and material consumed in the construction of a single mile; and not only that but the permanent wealth that has been so placed, and which insures so great an employment of labor and energy in its operation and maintenance. We can scarcely realize what an important factor in the permanent prosperity of a State the construction of such an amount of railway, and that in a single year, can have.

Nebraska is next on the scale with 1101 miles, Texas closely following with 1,055, and in their order Colorado, 818; Dakota, 760; Michigan, 700; Montana, 616; Missouri, 554; Indian Territory, 499, and so on. Four States and two Territories, viz., Kansas, Texas, Nebraska, Colorado, Dakota and Montana together show an addition of 6,420 miles, or over one-half the entire mileage. Although this mileage has been constructed by 364 different lines, it is also true that a greater part of it has been constructed by a few great companies—eleven companies having built 7,335 miles. They are as follows: Atchison, Topeka & Santa Fe system, 1,694 miles; St. Paul, Minneapolis & Manitoba system, 940 miles; Missouri Pacific system, 900 miles; Rock Island system, 825 miles; C. B. &. Q. system, 702 miles; Chicago & Northwestern system, 493 miles; the "Soo" system, 424 miles; Chicago, Milwaukee & St. Paul Railway, 375 miles; Union Pacific & St. Joe & Grand Island system, 345 miles; St. Louis & San Francisco system, 325 miles; Northern Pacific system, 312 miles.

Michigan has shared in the general progress, being sixth in the list as to mileage for the year, and from the reports for the year received at the office of the Commissioner of Railroads we glean that it is the greatest in its history. The mileage of new track in Michigan is as follows: Bear Lake & Eastern, 3 miles; Chicago, Kalamazoo & Saginaw, 31 miles; Chicago & Northwestern, 35 miles; Detroit, Bay City & Alpena, 28.55 miles;

Detroit, Lansing & Northern, 53 miles; Duluth, South Shore & Atlantic, 110 miles; Flint & Pere Marquette, 2.81 miles; Gogebic & Montreal River, 6.94 miles; Hastings & Lowell, 12 miles; Milwaukee, Lake Shore & Western, 2.40 miles; Michigan Central, 20 miles; Milwaukee & Northern, 25 miles; Minneapolis, Sault Ste. Marie & Atlantic, 192.24 miles; Manistee & Luther, 12.50 miles; Toledo, Ann Arbor & Cadillac, 66.30 Toledo, Saginaw & Muskegon, 96 miles; Toledo & South Haven, 16.01 miles; making a total of 717.75 miles, 17.75 more than credited to Michigan in the general report, which, added to the mileage reported at the close of 1886, will give Michigan a total mileage, January 1, 1888, of 6,259.38 miles. From present indications it is not probable that the present year will equal the past in the building of new railroad lines, although it is probable that quite a large mileage will be constructed, but the year 1887 will stand at the summit of railroad building in Michigan. In addition to the roads doing business as common carriers, the number of logging roads continues to increase, and there are probably nearly, if not fully, 500 miles of these in the State.

There has been expended for maintenance of way and buildings in Michigan, for the current year ending December 31, 1886, $12,121,071.23, or nearly one million more than the previous year, and constituting about twenty-two per cent. of the entire operating expenses of the roads. The number of track sections reported is 1,024, an average of about six miles each, with an average force of four men to each section, and just here I cannot forbear speaking a word in praise of this portion of the working force of the railways. Much has been said in praise of the railway employee in train service, and many are the ardent admirers of the engineer and fireman, the conductor and brakeman, who, as they whirl along over the track upon the train seem to the average looker-on to be sort of heroes, and indeed many of them are, and will bravely meet and face death if necessary in the performance of their duty. But who ever looked upon the section-man as a hero, or stops to think that upon them in their humble capacity depends more than upon almost any other the safety of the traveling public, and their fellow employees as well? Many are inclined to look upon the service they perform as of little account, and that they simply put in their time here and there and draw their pay when pay-day comes. Few know, or if they do know, stop to think, of the painstaking care and labor as he daily goes over his section and to his allotted task. Rain or shine, storm or tempest, he is expected to be on duty, and when the storm and danger are worst his work is the most arduous; and ever ready is he, night or day, to go at a moment's notice and see that all is well, or give timely warning of danger. All praise to the section-men! God bless them, every one!

1,547,150 new ties have been used for renewals during the year, an average of 276 per mile, which is a fraction less than for the previous year. An important problem is being presented to our railroad compa-

nies in the question of a substitute for wooden ties. Many experiments are being made in this and other countries with different materials, especially iron and steel in different forms, and it is certain that with the increasing value of timber and its growing scarcity the iron or steel tie will come into general use.

New rails, aggregating 3,066 tons, were used in renewing 303.74 miles of track in Michigan, about five per cent. of the whole. Nearly a mile of trestle has been filled with embankment during the year, and 275 timber culverts renewed, 209 of them with wood. 2,005 is the total of the bridges on Michigan railroads, with a total length of 257,965 feet, nearly forty-nine miles, an average length of 128 feet. Of wooden bridges proper we have 66,775 feet; stone and iron, 13,321 feet; combination, 3,857 feet; draw bridges, 2,234 feet; trestles proper, 171,784 feet. Of these 7,449 feet have been renewed with wood during the year, and 920 feet with stone or iron. No accidents are reported during the year resulting from weak or defective bridges.

The Commissioner has sent out during the present year a blank form of report and required of each railroad company a special inspection and report of each bridge structure on its road. These are for permanent record in the Commissioner's office. They require the number of the bridge, the location, the stream or water-way spanned, date of original construction, date of renewal or general repairs, length, height above low-water mark, depth of water under bridge, style of bridge, material, kind of abutments, kind of piles, foundation, length of span, number of bents in trestle, length of stringers, length of draw spans, general condition, date of last inspection, by whom made, and various other questions. An examination of these reports will enable the Commissioner to form a fair idea of the character and condition of the structure.

There are within the limits of Michigan 230 railway crossings, an increase of twenty-seven since the last report. Of these crossings twenty-one are over and under, and 209 are at grade. At all of these points the law of Michigan requires that all trains be brought to a full stop, not less than 200 or more than 600 feet from the crossing; still, with all the precautions that are taken, many accidents occur at these points. To avoid these stops, and prevent accidents as well, the interlocking and derailing switch is coming into popular favor. By means of this device, which is operated by a watchman in a tower, when one line is clear, switches on the other line are open, so that in the event of a train on the open line attempting to cross while the other has the right of way it is thrown from the rails onto the ties and stopped. Time will not allow a description of this device, but it will be readily understood without. The first of these switches in Michigan was put in at the crossing of the Grand Rapids & Indiana and Michigan Central, at Wasipi, in 1884, and all that have been put in have, I believe, proven efficient and satisfactory.

Of highway crossings there are reported 5,965, or a little less than one per mile of road.

As our railways are making improvements in all directions their buildings are not forgotten and we are coming to have some very creditable station buildings, notably those of the F. & P. M. at Flint and East Saginaw, and the Michigan Central at Ann Arbor and Kalamazoo and the one now building at Battle Creek. Of course we cannot expect to equal for years the Eastern States in the number of excellent railway buildings, but from the present outlook and start which our roads are now making we shall be second to none in variety, style and general excellence of our station buildings and railway structures.

One notable point in the building of railroads in Michigan for the past year is the attention which has been given to the Upper Peninsula, which has resulted in the building of two lines which are to become parts of great through routes and are to form an important factor in the great carrying trade of the Northwest, from its granaries, its mills and its mines to the Atlantic seaboard. Just what effect these lines will have on the traffic of the Northwest time alone will tell. Directly in connection with these two lines, which have added to our mileage for the year over 300 miles of road, we cannot fail to notice the Sault bridge which has been built to span the Sault River and Canal and to give these two roads connection with the Canadian Pacific, which is already built and open, and the Grand Trunk, which is pushing its way to the same connection. These bridges consist of ten spans of 240 feet each over the St. Mary's River, a swing bridge of 369 feet over the present Ship Canal, a 220 foot swing over the proposed Canadian Canal, and two 104 foot lattice griders over the Canadian Channel. Most of the piers are on rock bottom and are built in the most substantial manner. The masonry is of first-class, rock-faced Ashlar, no corner less than fifteen inches thick, and laid in Portland cement. The current is four and one-half miles per hour, and in the spring is probably more, and great quantities of ice are brought down.

The trusses and superstructure are first-class in every particular and are proportioned for the heaviest loads. They have been built by the Dominion Bridge Company of Lachine, for the Sault Ste. Mary Bridge Company.

Another important work which has been lately commenced and quite an amount of labor done and expense incurred is the proposed St. Clair River tunnel, the following facts in relation to which are kindly furnished me by Joseph Hobson, Chief Engineer of the Great Western division of the Grand Trunk Railway, who is the Engineer of the Tunnel Company, which company is formed by the consolidation of an American and a Canadian Tunnel Company.

THE ST. CLAIR RIVER TUNNEL.

The St. Clair River Tunnel is intended to connect the Grand Trunk and the Chicago & Grand Trunk Railway systems at Port Huron and Sarnia, although it will be built by a company independent of the corporations owning and controlling these railways.

At present the connection between the above mentioned lines is maintained by a ferry which transfers the trains between Point Edward in Canada and Fort Gratiot in Michigan. This ferry is about three miles north of the proposed tunnel.

The location of the tunnel was determined by the following considerations, among others:

1. The comparatively small depth of water at the proposed crossing. 2. The tunnel and its approaches can be constructed on the same straight line. 3. The short length of new railway that will be required; for all practical purposes the tunnel approaches connect immediately with the main lines of both the Grand Trunk and Chicago & Grand Trunk railways. 4. The distance to be run by all through trains to and from the Great Western division of the Grand Trunk will be reduced six miles, while it will not be increased for those to and from the Grand Trunk proper. 5. The favorable material in the bed of the river for tunneling. The borings show that the rock is from 90 to 95 feet below the surface of the water, and that strong clay, in which not a trace of quicksand was discovered, overlies it. 6. The necessary land and right of way for the tunnel and its approaches will cost less than upon any other line within the limits available for selection.

The advantages to be gained by the construction of the tunnel are a reduction in the cost and time of transferring trains, and a degree of regularity in the service not always attainable by the ferry in consequence of the river being occasionally obstructed by ice in the winter, and by vessels during the season of navigation.

The length of the tunnel will be one mile, of which 2,310 feet will be under the river, 1,160 feet under dry ground on the Canadian side, and 1,810 feet under dry ground on the American side. Of the portion under the river 1,500 feet will be nearly level, having merely enough fall toward the east to cause any water finding its way into the tunnel to flow in that direction. At either end of this part of the tunnel there will be a gradient rising 1 in 50 or at the rate of $105\frac{6}{10}$ feet per mile, which will be continued through the open cuttings forming the approaches. The total length of the ascent on the Canadian side will be 4,970 feet, and on the American side 4,900 feet. The length of the open cutting at the east end of the tunnel will be 3,270 feet, and at the west end 2,820 feet.

The depth of the lowest part of the tunnel below the surface of the water will be $80\frac{1}{2}$ feet; the minimum depth of the top of it below the bed of the river will be 15 feet.

The tunnel will be for single track only. In cross section it will be circular with a clear internal diameter of 20 feet.

The shafts on the American and Canadian side have both been sunk and on the Canadian side about 275 feet of the drift or experimental tunnel driven, when the workmen struck a small pocket of gas and water and were driven from the shaft. As no pumping machinery was at hand or in position, both shaft and drift having been perfectly dry, work was impeded until such machinery was procured and placed in position. As soon as this was done the water was easily pumped out and a bulkhead put in.

On the American side less than 100 feet of the drift was dug as the clay was too soft to retain its place until the curbing could be put in, so the work was stopped, and at present it remains like a woodchuck in winter, "*in statu quo.*"

The plan was to put through a drift eight feet in diameter as an experimental tunnel and crib it with wood for which purpose 12x12 pine timber was used. These timbers were cut two feet long and were dressed, key-shaped, to a radius of an eight foot circle, and put in in sections of two feet each leaving a bore of six feet inside diameter.

It is reported that arrangements have been made whereby work will be resumed within the next 90 days and the main tunnel pushed to completion as fast as possible, but the exact facts in relation to it are not easily obtained.

I had intended to describe briefly the Electric Railway at Port Huron which has in operation four miles of road; also to a most noteworthy piece of work which has been performed during the year, viz: the substituting of iron towers for the masonry ones in the Suspension Bridge at Niagara. So quietly was it done that probably very few outside the Engineering profession knew of its being an accomplished fact.

Worthy of note too is the remarkable tunneling work which has been done on the new Croton Aqueduct and on the Stampede Tunnel of the Northern Pacific.

I had also intended to refer to some matters of interest in my own experience in connection with bridge inspection and repairs and in right of way and land matters, but I have found the time at my disposal all too brief to accomplish the purpose I had in mind, and for want of time instead of material shall have to stop short.

THE PRESIDENT.—"Perhaps Mr. Reed will favor us with some of these thoughts at some future meeting. The outlook for the next year in the north of the State is certainly very excellent. There is a good deal of earnest work going on. We will have to hasten our business a little, so I call on Mr. Pearsons for his paper on 'Sources of Error in the Gradienter.'"

MR. PEARSONS.—"Prof. Cooley and Mr. Pierson have some remarks to make on the exhibit of surveying and other instruments, and my paper would properly be a supplement to these two. I would suggest that each member of the committee submit his remarks on the instruments he has examined."

Exhibit of Mathematical Instruments and Draughting Materials.

BY M. E. COOLEY.

The exhibit by F. Eugene Yale, of Ann Arbor, in this line comprises sets of instruments of the different grades of Keuffel & Esser's make, and is very complete. These instruments are so well known that a minute description would be superfluous. The larger dividers are made not only with the usual form of Swiss joint, but also with the Atteneder joint, which is a very perfect joint, giving a smooth and uniform motion, and proving very durable.

A special form of dividers for describing small circles in large numbers with rapidity, such as rivet work, will be found very perfect and an excellent addition to any draughtsman's outfit, as will also be found the sets of three small steel spacing pencil and ink dividers. A tendency is shown in the direction of instruments for a single purpose instead of the combination instruments. A number of little, time-saving devices, in the way of scale-guards, paper-cutters, etc., will be found of value to the Engineer.

On the whole, this exhibit shows a very praiseworthy effort on the part of Mr. Yale to keep in stock such a line of instruments and draughting materials as will enable our Engineers to secure what they want without the cost and delay of sending to New York, and his efforts should meet with the cordial support of our members. Mr. Yale also proposes to offer to members of this Society a special discount from the prices mentioned in the catalogues.

Messrs. W. & L. E. Gurley, of Troy, N. Y., exhibited a full line of instruments manufactured by them. This firm have exhibited their instruments year after year at the meetings of this Society, thus affording the members an excellent opportunity of noting the improvements which are yearly being made in this department. Their exhibit of transits in their various forms and levels, while not as great in numbers as at some former meetings, was fully up to their usual standard of excellence.

This firm shows also a Vernier pocket compass, with a novel telescopic sight attached. The construction of this instrument is such as to admit of the attachment of a vertical circle and level to telelcope; it has also clamp and tangent to lower limb. This class of instrument is very

convenient for reconnoisance or work of a similar nature, but the Surveyor should not allow himself to use instruments of this class when accuracy is required.

Mr. J. J. Holmes, of Batavia, N. Y., exhibited his solar theodolite. The solar theodolite is an instrument designed for obtaining a true meridian line, from the sun or some fixed star, independently of the magnetic needle. It combines all the features of the Engineer's Y level and transit, is simple in all its parts and adjustments. It is particularly adapted to work of this class, and the latitude arc equatorial plate and declination arc have a greater radius than usual in this class of instruments, thus ensuring a high degree of accuracy. Mr. Holmes gave a practical illustration of the utility of this instrument by placing a true meridian line in the park.

Mr. Holmes exhibited also a plain Engineer's transit, substantially like the solar theodolite below the standards.

THE PRESIDENT.—"I feel, gentlemen, when I view these instruments, that there are special thanks due the exhibitor, Mr. Yale. It is quite a piece of information to us that we need not send to New York when we need anything of this kind. A number of times we have done without some of these articles, when had we known they could have been obtained so easily at Ann Arbor we would have sent for them."

MR. MILLOE, AGT.—"Our intention is to sell these at a reduced rate to the Society, so as to cover the expense of getting the instruments, which you will save if you buy them from us."

Mr. Pearsons then read his paper on "Sources of Error in the Gradienter," which gave rise to a sharp discussion pro and con as to the principles involved. The paper not being left with the Secretary for publication, the discussion is omitted.

THE PRESIDENT.—"We have some new instruments just brought here by Mr. Holmes, of Batavia, N. Y. He has been with us before, and now we would like to have him bring his instruments forward."

Mr. Holmes brought forward an Engineer's transit and his solar theodolite, and briefly called attention to their construction and the fine workmanship. Both were fine instruments, the solar theodolite being a magnificent instrument, capable of doing any kind of work of which the transit, level, or solar compass are capable, and doing it in the most accurate manner.

Mr. Sturgeon, representing the Columbus Sewer Pipe Company, was called on, and called the attention of the Society to the second-class sewer pipe sold by that company and its value for drainage purposes. For that use it works as well as the first-class pipe and is furnished at a very much less cost.

Adjourned till evening.

Thursday evening session was spent in a general discussion of the Constitution and By-Laws of the new Society, which had been prepared in part by the incorporators at Lansing, Oct. 12, 1887, and completed by the associate members at this meeting. A very full discussion of the matter was had, and various changes and amendments suggested and agreed upon by the members of the old Society. The Constitution and By-Laws, as thus amended and agreed upon, were presented to the members of the incorporated Society for consideration.

MR. COOLEY.—"I move the adoption of the Constitution and By-Laws as amended and agreed upon."

The motion was put and carried. Yeas, Messrs. Steele, Hodgman, Pearsons, Appleton, Cooley—5; nays—0.

MR. HODGMAN.—"I now move that all the property and assets of the old Michigan Engineering Society be transferred to the newly incorporated Michigan Engineering Society."

The motion was carried without dissent.

MR. HODGMAN.—"As a member of the new Society, I move that it assume and become responsible for all the obligations of the old Michigan Engineering Society."

This motion was also carried without dissent.

Resolutions of thanks to the people and press of Kalamazoo for their kindness and courtesy were offered by Mr. Appleton and unanimously adopted.

While the Constitution and By-Laws were being engrossed, Mr. Holmes was called upon to make a statement in regard to the Invention of the Solar Compass, and he responded as follows:

Invention of the Solar Theodolite.

Mr. Chairman and Gentlemen of the Convention:

I can give you no information which led Mr. Burt to bring out the solar compass, but perhaps it may not be entirely uninteresting to the members of this Society if I state briefly the train of thought which brought about the *solar theodolite*. It did not spring at once into its present state of perfection, but was of slow growth. I have, from time to time, modified its construction and made such improvements as would better adapt it to the every-day work of the practical Engineer and Surveyor as a field instrument.

As a practical Surveyor I found I needed something better than the magnetic needle to guide me unerringly to the true north, and consequently after becoming familiar with the methods of obtaining the true meridian from the pole-star, was led into the subject of horology more extensively.

In making a sun-dial from the directions given in the Cambridge mathematics, for my latitude, I found that as the line of the latitude increased that a corresponding change was made in the tangent which governed the hour angle, or the position of the shadow of the gnomon. And if the latitude of the place were 45° the angle of the shadow on a horizontal plane would correspond with the hour angle from the meridian counting 15° for each hour. And if a circular plane be mounted at right angles to the stile, or polar axis, and from its centre a pin or rod perpendicular to this plane be placed, the shadow of the rod cast by the sun will fall upon each 15° angle for each hour; and by erecting a graduated arc perpendicular to this plane, and placing a point at the graduation representing the sun's declination, its shadow could not be thrown to the point of this arc, only when the gnomon is placed in the plane of the meridian.

When I had so made my dial I found that I had really made an exact *meridian finder*, differing in no essential principle from Burt's solar compass. In examining works on dialing I did not find that anyone had really caught the true economic principle of dialing applied to the practical purpose of obtaining a meridian line, although I found dials made, the gnomons of which cast shadows on all conceivable planes, whether horizontal, perpendicular or inclined. My surprise was great, however, when I afterwards found in the works of Dr. Thomas Dick, under the article on the Equatorial Telescope in the *Practical Astronomer*, a description of an instrument not only capable of finding the true time but the true meridian, also.

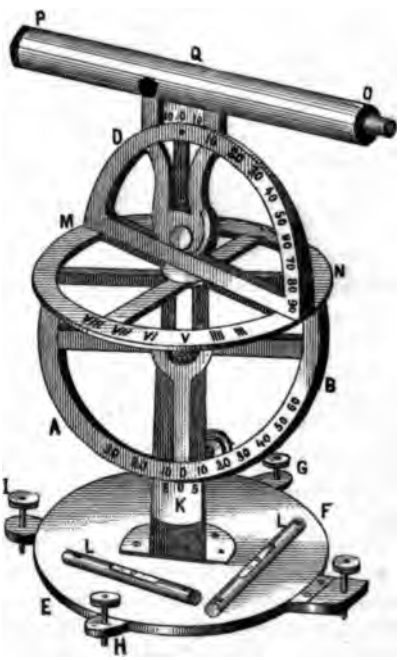
Dr. Dick says Christopher Schiner is supposed to have been the first astronomer who, in the year 1620, made use of a polar axis, but without any appendage of graduated circles.

In 1741 Mr. Henry Hindley, a clock maker in York, added to the polar axis an equatorial plate, a quadrant of altitude and declination semi-circle, but when this piece of mechanism was sent to London for sale, in 1748, it remained for the space of thirteen years.

Various modifications have since been made, one of the most simple of which may consist of the following parts, to-wit: A horizontal circle E. F., divided into four quadrants of 90 degrees each. There is a nonius at N. The circle is capable of being turned round on an axis. In the centre of the horizontal circle is fixed a strong upright pillar which supports the centre of a vertical semi-circle A. B., divided into two quadrants of 90 degrees each. This is called the semi-circle of altitude; it has a nonius plate at K. At right angles to the plane of this semi-circle

the equatorial circle M. N. is firmly fixed. It represents the equator and is divided into time twelve hours. Upon the equatorial circle moves another circle, carrying a nonius by which the divisions on the equatorial may be read; and at right angles to this movable circle is fixed the semi-circle of declination D., divided also into two quadrants of 90 degrees each. The telescope P. O. is surmounted above this circle and is fixed to an index movable on the semi-circle of declination, and carries a nonius opposite to Q. There are two spirit levels fixed on the horizontal circle at right angles to each other by means of which this circle is made perfectly level when observations are to be made.

The following cut shows the general plan of the instrument.



On motion of Mr. Cooley it was voted to pay the Secretary $50 for services the past year.

The Committee on Questions of Practice made a report, which, for want of time, was not acted on by the Society.

The Society then elected, *viva voce*, the following officers for the term ending, October 10, 1888:

President—GEO. E. STEELE, of Traverse City.

Vice-President - JOSEPH RIPLEY, of Sault Ste. Marie.

Secretary—F. HODGMAN, of Climax.

Treasurer—GEO. S. PIERSON, of Kalamazoo.

Directors—M. E. COOLEY, WM. APPLETON, A. L. DREW.

The following nominations were made for officers for the year beginning October 10, 1888, to be submitted to the members of the Society, to be voted on by letter ballot:

For President—Geo. E. Steele, A. L. Reed, J. B. Davis.

For Vice-President—Joseph Ripley, E. F. Guild.

For Secretary—F. Hodgman.

For Treasurer—Geo. S. Pierson.

For Directors—M. E. Cooley, Wm. Appleton, A. L. Drew, E. Dennis, A. J. Teed, J. H. Forster.

Bean's Cross-Section Rod.

F. Hodgman, Esq., Sec. Michigan Engineering Society, Climax, Mich.

DEAR SIR:—In response to the President's request I herewith send you a short account of my experience with Mr. H. F. Bean's Cross-Section Rod. I took advantage of the privilege which Mr. Bean granted to the members of the Michigan Engineering Society, and made a rod for myself, and have had it in constant use for two years and a half.

Experience shows that it is unnecessary to run check levels when using this cross-section rod, for the cross-sectioning and checking can all be done at once and in less time than it can be done by the old method of using a target rod. The most important feature of this rod is the elimination of the height of instrument. The rod is made to slide up and down on a leveling-rod, so that it has a double use.

Let the following represent part of a page of cross-section book:

Cuts—Roadway, 20 ft.; embankment, 14 ft ; slope, 1½ to 1.

STATION.	ELEVATION.	GRADE.	LEFT SIDE	CENTRE.	RIGHT SIDE.
478	78.77	78.77	4.7 17.1	5.0 0	5.3 18.0
479	78.87	.41 74.18	5.0 17.5	4.7	5.0 17.5
480	77.47	74.59	2.8 14.2	2.9	2.6 13.9
78	74.91	74.91		0.0	
481	74.06	75.00	0.6 7.9	1 1	1.0 8.5
482	70.16	75.00	5.0 14.5	4.9	4.8 14 2
483	74 02	75.00	1 5 9.3	1.0	0.5 7.8
18	75.00	75.00		0.0	
484	76.82	75.00	1.1 11.7	1.8	1.7 12.6
485	77.62	75.00	1.7 12.6	2.6	3.0 14.5
72	75.00	75.00		0.0	
486	74.02	75.00	2.3 10.5	1.0	0.8 8.2
99	74.79	74.79		0.0	
487	74.98	.2 74.80	0.4 7.6	0.2	0.0 7.0
488	75.91	74.60	1.0 11.5	1.3	1.1 11.7
489	78.73	74.40	4.4 16.6	4.3	4 9 17.4
42.7	74.32	74.32		0.0	
490	73.37	74.20	1.1 8.7	0.8	1.5 9.3

The cut side of the rod is adjusted at station 478, so that five feet coincides with the horizontal hair of the instrument With a tape graduated for the width and slope of the excavation and embankment, the rodman quickly finds the approximate position of the slope stake. Its location then can be determined with the instrument in one or two trials, by the Engineer calling the *cuts*, read from the rod, and the rodman trying the same cuts marked on the tape until the two agree. A record is made of the depth of the cut, read directly from the cross-section rod, and the distance out, which the rodman finds by turning over his tape line. All of this has been done as quickly as three men can work, and as accurately as the most careful computation which an Engineer could make, without the trouble and time of going through the many trial additions and subtractions necessary when using the ordinary tape and target rod.

The levels, the work of calculating the grade line and centre cuts and fills, can all be checked, as the cross-sectioning proceeds, by keeping notes, similar to those below, on a loose piece of paper or fly-leaf of the note book. In this case the grade ascends 41 feet per 100 feet. At station 478 the bottom of the cross-section rod is opposite 2 87 feet on the level rod. Then, as the grade ascends .41 feet each station, the cross-section rod must be lowered just that much, to have it read *cut 4.7 feet* for the centre depth of the next station.

CHECK NOTES.

Sta. 478	2.87	Sta. 481 to 486 level		Sta. 489	3.63
" 479	−.41 = 2.46	" 484 turned	3.03	" 490	+.20 = 3.83
" 480	.41 = 2.05	" 487	+.20 = 3.23		
" 481	.41 = 1.64	" 488	.20 = 3.43		

In the cut the zero of the cross-section rod has been above the cross hair. When the rod is placed on the peg at station 481 the zero is found to be below the cross hair. The rod is turned around and reads *fill 1.1 feet*, and corresponds to the centre fill, previously calculated and written in the book, if the Engineer has made no errors in his levels or calculations. If the book and rod do not agree, then the preceding work is wrong somewhere, because by shortening the rod at each station to correspond to the ascending grade line the plane of the instrument has been raised to the position of the grade line, so to speak (for the H. I. is eliminated by this rod), a measurement is made between the grade line and

the surface of the ground. A graphic demonstration of this can be made by drawing a profile of the work, with a sketch of the rod and instrument, with the line of its level plane projected.

After setting the slope stakes at station 481, the rod is moved toward station 480 until zero is within a few tenths of the cross hair. The intersection of the grade and ground is estimated to be 20 feet back of 481. $.20 \times .41 = .082$. .08 feet above the zero does not quite reach the cross hair. At 22 feet back it almost reaches. $.22 \times .41 = .1002$, so a hub is set so that the reading is .1 foot above zero. Thus we have grade at station 480 + 78. For finding intersection of grade and ground it is not necessary to adjust the rod for the intersection. Use the adjustment for the nearest station, taking a reading, which the plus measurement requires, *above zero in ascending a grade line, or below zero in descending it.*

At 481 a level grade line is reached, and the cross-section rod must remain with its bottom set opposite 1.64 on the level rod, during this "set." On this level grade the depths of the embankment at station 482 and 483 are read and recorded with as much facility as a man can read and write the time indicated by the dial of a clock. The grade at 483 + 18 is found by moving the rod along the centre line until the cross hair intersects the rod at zero, and a plus measurement taken between the rod and the station. The rod is turned with the *cut* side toward the instrument at station 484. The centre cut checks on 1.8 feet. Slope stakes are set as before, and the instrument carried forward for the next set. When the instrument is again leveled the rod is adjusted to read, *cut* 1.8 feet, on station 484, the same as the last reading. The bottom of the rod is opposite 3.03 on the level rod. Enter this on the loose paper notes to make calculations for future adjustment. A little study of the graphic demonstration (remembering that H. I. is eliminated) will show that all which has been done thus far in this set is the connecting link of the *checking.*

All the operations where the level grade line is will be similar to those before described. The rod will be clamped at 3.03 until 486 is passed. Here the grade begins to descend .2 feet each station, so the rod is raised .2 feet, or set at 3.23, for 487. The grade stake is set with a reading .01 feet below zero at 486 + 99. At 488 and 489 the rod is raised as indicated on the loose paper notes. At 489 + 42.7, the grade hub is set by using the same adjustment used at 489, and the reading ($.427 \times .2 - .0854$) .08 feet above zero, because we descend the grade line. At 490 the zero falls below the cross hair, and with the bottom of the cross-section rod set opposite 3.83 on the level rod, we have a reading of fill .08 feet, which checks with the note-book if all the work of leveling and calculating has been done correctly. It might be added that levels can be run with this rod, reading the elevations directly from the rod in the following manner: The *cut*-side of the rod is always toward the instrument. The units, tenths and hundredths of the elevation are adjusted to

the cross-hair of the instrument, and the tens, hundreds, or higher notations are mentally added. On all succeeding stations the inverted figures of the *cut*-side show the units, tenths and hundredths of their respective elevations. On the turning point the elevation is adjusted similarly to that on the first station, and the operation repeated each set.

A black-board exercise would bring out these points more clearly.

Very truly, GEO. L. WELLS,
Assistant Engineer T. A. A. & C. Ry.) Cadillac, Mich.

Some Points for Surveyors who Have a Transit which They can Rely on.

F. HODGMAN.

In running lines in an open country, where a sight can be had from one corner to another, I have saved time and labor in some instances in the manner illustrated by the following examples:

EXAMPLE 1.—Ran a quarter line, part of which was along a fence overgrown with bushes and small trees. Set up a flag at one quarter post; measured alongside the fence-row in the cleared field without running line, setting temporary stakes every ten chains across the section. Found the other quarter-post and could not see flag from it because of hedge-row; offset along the section-line with the transit till I could see the flag; sighted to it, measured the offset, say one chain; turned to my table of departures in field-book and found the corresponding angle to be 43′; turned it off on the transit and ran a parallel line back, setting stakes in the true line by one chain offsets as often as wanted.

EXAMPLE 2.—In an open country where I had planted permanent monuments at all the Government corners. Subdividing a section. Sent men to put flags up at all the quarter-posts; went with transit to centre of section, intending to put it in line each way between the flags, but could not because of fences. Set up transit in N. and S. quarter line, as near as I could tell, Vernier at 0, backsight on east quarter-post, reversed telescope, loosened upper clamp and sighted to west quarter-post; read the angle, which was, say, 25′; turned to table of departures and found this to be equivalent to an outing of 29 links, hence my transit was 14½ links from true line at the centre. On the other line, by reason of alternating woods on opposite sides of the line, I went to a point 20 chains from one quarter-post, backsighted on the other as before, setting temporary stakes near centre; sighted to the other quarter-post and measured the angle of deflection, which was, say, 36′, which I find from my table of departures to be equivalent to 21 links outing; hence my transit is 15¼ links from true line, and temporary stake near centre is 7¼ links from true line. Being somewhat lazy, I save myself some two or more miles walk by the operation.

Method of Determining a Meridian.

The following example of a method of determining a true meridian by observation of the circumpolar stars when both are behind a plumb line or in the same vertical plane, is furnished by Seth Pratt, County Surveyor of Barry County:

To find the equal azimuth of two circumpolar stars

The most advantageous of which are Polaris with Alioth, Gamma, Kochab, Dubhe, Bemtnash, or any of the bright stars whose polar distance does not exceed 40° or 41°.

Let R and R′ represent respectively the Right Ascensions of Polaris and another star.
Let h and h′ their hour angles.
Let t and t′ their times of passage above the Pole.
Let P and P′ their polar distances = 90° — declination.
Let Z their zenith distance of the place = 90° — lat.
l = longtitude in time West.

$r = \frac{1}{365.242216} = .002737909 +$ or $1 + r = \frac{366.242216}{365.242216} = 1.0027379091359$ = ratio of sidereal to mean or clock time.

T = Sidereal time Jan. 1st of the given year at Greenwich Mean Noon.
n = No. of days after Jan. 1 of the given year to G. M. Noon of date.
s = 24 r = 0h 065709812614.
a and a′ the azimuths.

For the Meridian passage. Jan 1st, 1888. Lat. N. 42° 15′ Long. 85° 10′.

$t = \frac{R - (T + ns + rl)}{1 + r}$ P = 1° 17′.309 = 1°.2884833 P = 33° 25′.94½ = 33°.4324444 n = 0 V is an auxiliary angle.

R	= + 1h.2952834		
T	= — 18.7056737		
n s	= — .0000000		
r l	= — .0155452	R′	12.8183944
sum of	= — 18.7212189		— 18.7212189
Diff.	= — 6.5740645	Diff	+ 18.0971755
÷ 1 + r = t above pole	+ 6.5561144	÷ 1 + r = t′ above pole	+ 18.0477427
		Subtract	— 11.9672348
t − t′ =	.4756065	t′ below pole	+ 6.0805079

To find a time H between t and t′ when the two stars will have nearly the same azimuth. Assume that stars near the Meridian pass in azimuth approximately as their polar distances. Therefore,

As P + P′ : $\left\{\begin{matrix} P \\ P' \end{matrix}\right.$: : t − t′ : $\left\{\begin{matrix} \text{Correction for h′} = .0176499 \\ \text{Correction for h} = .4579566 \end{matrix}\right.$

t′ = 6.0805079
c = — .0176499

t = 6.5561144
c = — .4579566

H = + 6.0981578

H = + 6.0981578

For the hour angles h and h′ for the time H.

h = (1 + r) (H + l) + T + n s — (R + l)

(1 + r) (H + l)	= + 11.8081770		
T	= + 18.7056737		
Sum	= + 6.5138507		+ 6.5138507
—(R + l)	= + 6.9730012	—(R′ + l)	+ 18.4961722
h West	= + 23.5407895		12.0176785
h East—sup. of 24h	= + .4592105	Excess of 12h = h′ East	= — .0176785

By the 1st and 2nd of Napier's Analogies.

Cos ½ (Z + P) : cos ½ (Z — P) : : cot ½ h : tan ½ (V + A) ½ (V + A) — ½ (V — A) = A
Sin ½ (Z + P) : sin ½ (Z — P) : : cot ½ h : tan ½ (V — A)

½ (Z + P′) = 10° 35′.47½	Sin = 9.813353 Cos = 9.880454	½ (Z + P) = 24° 31′.1545	Sin = 9.618147 Cos = 9.958956
½ (Z — P′) = 7° 9′.52½	Sin = 9.995727 Cos = 9.996602	½ (Z — P) = 23° 13′.8455	Sin = 9.595976 Cos = 9.963279
Cos ½ (Z + P) A. C.	.041044	Cos ½ (Z + P′) A. C.	.119546
Cos ½ (Z — P)	9.963279	Cos ½ (Z — P′)	9.996602
(1)	10.004323	(3)	10.116148
Cot ½ h	11.22052	Cot ½ h′	12.635605
Tan ½ (V + A) (86° 35′.397)	11.224843	Tan ½ (V + A) (89° 53′ 9113)	12.751753

Sin ½ (Z + P) A. C.	.381953	Sin ½ (Z + P′) A. C.	.186847
Sin ½ (Z — P)	9.595976	Sin ½ (Z — P′)	9.095727
(2)	9.977929	(4)	9.282374
Cot ½ h	11.220527	Cot ½ h	12.635605
Tan ½ (V — A) (86°22′.610)	11.198456	Tan ½ (V — A′) (89°18′.3785)	11.917979
A =	12′.787	A′ =	35′.4328
		A =	— 12′.7870
		A′ — A =	22′.6458

For the correction of the hour angles by their azimuths.

A is decreasing at the rate of $\frac{A}{h}$ minutes of arc in 1 hour.

A' is increasing at the rate of $\frac{A'}{h'}$ minutes of arc in 1 hour.

Their difference $= \frac{A}{h} - \frac{A'}{h'} = \frac{A\,h' - A'\,h}{h\,h'}$ minutes of arc in 1 hour.

And $(A \sim A) + \frac{A\,h' - A'\,h}{h\,h'} \cdot \frac{h\,h'}{A\,h' - A'\,h} \cdot (A' \sim A) = c = .0114503$ which is to be subtracted from the hour angle too great and added to that too small.

h = - - - -	.4592105	h' - - =	.0176785
c = + - - -	.0114508	c - - - -	.0114508
h c = - - -	.4706613	h' c = - -	.0062277
½ h in arc = 3°31'.797225		½ h' in arc = 2'.802825 cot = -	13.083678
Cot ½ h = - -	11.209805	Eq (3) - - - - - - -	10.115144
Eq (1) - -	10.004323	Tan ½ (V ~ A') (89° 58'.256) - -	13.204 25
Tan ½ (V ~ A)	11.214125 86° 30'.2955		

Cot ½ h -	11.209805	Cot ½ h' c - - - - - - -	13 08-678
Eq 2) - -	9.977929	Eq (4) - - - - - - - - -	9 2*2374
Tan ½ (V—A) =	11.187734 86° 17'.1915	Tan ½ (V — A') (89° 45'.320) -	12.3715.52
A =	13'.104)	A'	12'.386

Another approximation will give nearly the correct azimuth, viz: A = A' = 13' 5''.75 East

Mean time of equal azimuths Jan. 1 at $6^h\ 6^m\ 34^s.59$ P. M.

This method is independent of a time piece.

The instant of observation being when the two stars are behind a plumb line. Observations may be made at several successive nights and a mean of them taken

* (P ~ P') When the stars are moving in different directions otherwise. (p — p')

SETH PRATT, C. E.

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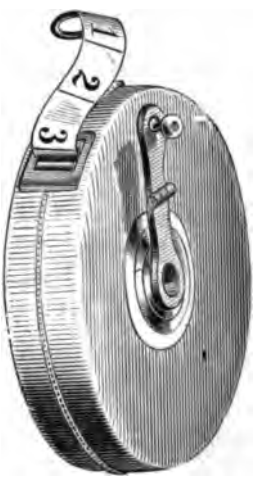

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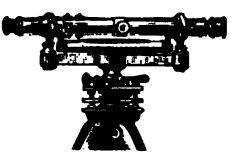

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